

Figure S1 (related to Figure 1). **Flow cytometry gating scheme and cardiac phenotype of** *Tnnt2*^{$^{AK210/_{AK210}}$ **mice across the spectrum of age. A**, Flow cytometry gating strategies for cardiac macrophages. **B**, Kaplan-Meier curve showing reduced survival of *Tnnt2*^{$^{AK210/_{AK210}}$ mice compared to controls (n>20 per group). **C**, Heat map showing genes differentially expressed in control and *Tnnt2*^{$^{AK210/_{AK210}}$ hearts at 8 weeks of age (n=5-6 per experimental group). Representative genes related to macrophages and innate immunity that were differentially expressed in *Tnnt2*^{$^{AK210/_{AK210}}$} hearts compared to controls are displayed. CPM: counts per million. FDR p<0.05 (control vs *Tnnt2*) for comparisons. **D-E**, Immunostaining of control and *Tnnt2*^{$^{AK210/_{AK210}}$} hearts showing increased numbers of CD68⁺ (white) macrophages in *Tnnt2*^{$^{AK210/_{AK210}}} hearts compared to controls at P7 and 8 weeks of age. Green: cardiac actin. * denotes p<0.05 compared to controls. Mann-Whitney test. n=6 per experimental group.$ **E**, Flow cytometry of CD45⁺CD64⁺Ly6G⁻ macrophages showing shifts in macrophage composition in control and*Tnnt2* $^{<math>^{AK210/_{AK210}}} hearts across the spectrum of age. n=6 per experimental group.}}}</sup>$ </sup>



Figure S2 (related to Figure 1). Recruitment dynamics and origins of cardiac macrophages in control and *Tnnt2*^{4K210/4K210} mice. A, Immunostaining for CD68 (red) and GFP (green) in control ($Ccr2^{GFP/+}$), $Ccr2^{GFP/GFP}$, $Tnnt2^{\Delta K210/\Delta K210}$ $Ccr2^{GFP/+}$, and $Tnnt2^{\Delta K210/\Delta K210}$ $Ccr2^{GFP/GFP}$ hearts at 8 weeks of age. Representative images of n=6-8 per experimental group. Scale bar 20µm B, Quantification of CCR2⁻ and CCR2⁺ macrophages in the LV myocardium of Ccr2^{GFP/+}. $Ccr2^{GFP/GFP}$, $Tnnt2^{\Delta K210/\Delta K210}$ $Ccr2^{GFP/+}$, and $Tnnt2^{\Delta K210/\Delta K210}$ $Ccr2^{GFP/GFP}$ hearts. * denotes p<0.05 compared to control (Mann-Whitney test). n=6-8 per experimental group. C, Flow cytometry of CD45+CD64+Ly6G- macrophages in $Tnnt2^{\Delta K210/\Delta K210}$ Ccr2^{GFP/+} and $Tnnt2^{\Delta K210/\Delta K210}$ Ccr2^{GFP/GFP} hearts at 8 weeks of age showing specific reductions in only CCR2⁺ macrophages. * denotes p<0.05 compared to $Tint2^{\Delta K210/\Delta K210}$ Ccr2^{GFP/GFP} hearts (Mann-Whitney test). n=6 per experimental group. D, Immunostaining for CD68 (red), GFP (green), and Ki67 (white) in control and *Tnnt2^{ΔK210/ΔK210}* hearts at 8 weeks of age showing increased proliferation of CCR2⁻ macrophages in $Tnnt2^{\Delta K 210/\Delta K 210}$ hearts. n=6 per experimental group. Scale bar 20µm. E. Quantification of the percent of CCR2⁻ and CCR2⁺ macrophages that expressed Ki67. * denotes p<0.05 compared to controls (Mann-Whitney test). n=6-8 per experimental group. F-G, Flow cytometry of CD45⁺CD64⁺Ly6G⁻ macrophages in control (*Flt3-cre Roas26-tdTomato*) and *Tnnt2*^{*AK210/AK210} Flt3-cre Rosa26-tdTomato* hearts at 1 week and 12 weeks of age showing that</sup> the percent of CCR2⁻ and CCR2⁺ macrophages derived from definitive hematopoietic progenitors (tdTomato⁺) remains unchanged between control and $Tnnt2^{\Delta K210/\Delta K210}$ hearts, B. E. G: each data point represents a biologically independent replicate (n=5-6 per experimental group).



Figure S3 (related to Figure 1). **CCR2**⁻ **and CCR2**⁺ **macrophages have distinct gene expression profiles in dilated cardiomyopathy. A**, Hierarchical Clustering of CCR2⁺MHCII^{hi}Flt3⁺, CCR2⁻MHCII^{lo}Flt3⁻, CCR2⁻MHCII^{lo}Flt3⁺, CCR2⁻ MHCII^{hi}Flt3⁺, and CCR2⁺Ly6C^{hi} monocytes FACS sorted from 8-week-old *Tnnt2*^{AK210/AK210} mice. n=5-7 per experimental group. **B**, Principal component analysis (PCA) highlighting that CCR2⁺MHCII^{hi}Flt3⁺ macrophages cluster independently from each of the CCR2⁻ macrophage populations. Each data point represents biologically independent samples. **C**, Bar graph showing the number of differentially expressed genes (FDR p<0.05, fold change>1.5) for each of the listed comparisons. Blue: upregulated in *Tnnt2*^{AK210/AK210} mice. Red: down regulated in*Tnnt2*^{<math>AK210/AK210} mice. **D**, Pathways enriched in CCR2⁺ and CCR2⁻ (all subgroups combined) macrophages. **F**, Heat maps listing individual genes differentially expressed in CCR2⁺ and CCR2⁻ macrophages. Scale bar denotes fold change.</sup>



Figure S4. CCR2⁻ macrophage ablation and adverse LV remodeling (related to Figures 2-4). A, Flow cytometry of macrophages (CD45⁺Ly6G⁻CD11b⁺CD64⁺) isolated from the hearts of control (Cx3cr1-GFP/+ Ccr2-RFP/+) and CD169-DTR (CD169-DTR Cx3cr1-GFP/+ Ccr2-RFP/+) mice. n=6 per experimental group. B, Quantification of flow cytometry data showing depletion of CCR2⁻ macrophages and no changes in the abundance of CCR2⁺ macrophages, monocytes, or neutrophils. Each data point denotes a biologically independent sample (n=6 per experimental group). * denotes p<0.05 compared to controls (Mann-Whitney test). C, Quantitative RT-PCR for chemokine and cytokine mRNA expression in CCR2⁺ macrophages isolated from control (Cx3cr1-GFP/+ Ccr2-RFP/+) and CD169-DTR (CD169-DTR Cx3cr1-GFP/+ Ccr2-RFP/+) hearts. Each data point denotes a biologically independent sample (n=4-6 per experimental group). No statistically significant differences were observed (Mann-Whitney test). D-E, Wheat germ agglutinin (WGA, D) and Picrosirius red (E) staining of control, CD169-DTR, *Tnnt2^{ΔK210/ΔK210}*, and Tnnt2^{ΔK210/ΔK210} CD169-DTR hearts after 3 weeks of DT treatment. Scale bar 20µm F-G, Quantification of cardiomyocyte cross-sectional area and fibrotic density in the hearts of control, CD169-DTR, Tnnt2^{ΔK210/ΔK210}, and Tnnt2^{ΔK210/ΔK210} CD169-DTR mice after 3 weeks of DT treatment. * denotes p<0.05 compared to controls. Each data point represents a biologically independent replicate. **H-J**, Box and whisker plots of *Nppa*, *Npp*b, and *Myh7* mRNA expression in control, CD169-DTR, Tnnt2^{ΔK210/ΔK210}, and Tnnt2^{ΔK210/ΔK210} CD169-DTR hearts after 3 weeks of DT treatment. * denotes p<0.05 compared to controls. n=5-6 per experimental group. K, Gelatinase activity assay showing minimal metallomatrix proteinase (MMP) activity in control and Tnnt2^{-/K210/_/K210} hearts. Tnnt2-DTR mice (DT-cardiomyocyte ablation model) treated with DT were included as a positive control as they display marked increase in MMP activity following cardiomyocyte cell death and resultant inflammatory cell infiltration. * denotes p<0.05 compared to controls. Each data point represents a biologically independent replicate. n=4-9 per experimental group.



Figure S5 (related to Figures 2-4). Telemetry, atrioventricular node macrophages, and myocardial metabolism following CCR2⁻ macrophage depletion. A, Representative ECG tracings of control, CD169-DTR, *Tnnt2*^{$\Delta K210/\Delta K210}, and$ *Tnnt2* $^{<math>\Delta K210/\Delta K210}$ CD169-DTR hearts after 3</sup></sup> weeks of DT treatment. B-C, Quantification of R-R, PR. QRS, and QT intervals in each experimental group. Prolongation of the QT interval was observed in *Tnnt2*^{ΔK210/ΔK210} and *Tnnt* $2^{\Delta K^{210}/\Delta K^{210}}$ CD169-DTR hearts compared to controls. * denotes p<0.05 compared to controls. Each data point represents a biologically independent replicate. 6-8 mice per experimental group. D, Left, representative image of HCN4 immunostaining (red) showing staining in the atrioventricular node. DAPI: blue. Scale bar 100um. Center. immunostaining for GFP (green) and RFP (red) in the atrioventricular node of control (Cx3cr1-GFP/+ Ccr2-RFP/+) and CD169-DTR (CD169-DTR Cx3cr1-GFP/+ Ccr2-RFP/+) mice. The atrioventicular node region was identified in serial sections using HCN4 staining. DAPI: blue. Scale bar 50µm. Right, guantification of CCR2⁻ and CCR2⁺ macrophages in the atrioventricular node of control (Cx3cr1-GFP/+ Ccr2-RFP/+) and CD169-DTR (CD169-DTR Cx3cr1-GFP/+ Ccr2-RFP/+) mice. * denotes p<0.05 compared to controls. Each data point represents a biologically independent replicate (n=4). All immunostaining studies were performed in 4 independent specimens. E, Oxygen consumption rate (OCR) in mitochondria isolated from the hearts of control, CD169-DTR, $Tnnt2^{\Delta K^2 10/\Delta K^2 10}$, and $Tnnt2^{\Delta K^2 10/\Delta K^2 10}$ CD169-DTR mice after 3 weeks of DT treatment. Mitochondria were provided either glutamate/malate or succinate substrates. ADP was added to measure maximal OCR. Each data point represents mitochondria preparations from an individual hearts. n=5-6 mice per experimental group.



Figure S6 (related to Figures 2-4). **CCR2**⁻ **Macrophages Promote Adaptive Remodeling following Pressure Overload. A**, Echocardiographic analysis of control and CD169-DTR mice performed 4 weeks after sham surgery or transverse aortic constriction (TAC). * denotes p<0.05 compared to control, ** denotes p<0.05 compared to control TAC group (ANOVA, post-hoc Tukey). n=4-5 per experimental group. LVIDd: LV end diastolic dimension. **B-D**, Quantification of myocardial fibrosis (B, Trichrome staining, scale bar 20µm), cardiomyocyte cross-sectional area (C, WGA staining, scale bar 20µm), and myocardial microvascular density (D, CD34 staining, scale bar 40µm) in control and CD169-DTR hearts 4 weeks after sham surgery or TAC. * denotes p<0.05 compared to control, ** denotes p<0.05 compared to control TAC group. Each data point represents a biologically independent sample. **E**, RT-PCR measuring the expression of *Nppa*, *Nppb*, and *Myh7* mRNA in the hearts of control and CD169-DTR mice 4 weeks after sham surgery or TAC. * denotes p<0.05 compared to control, ** denotes p<0.05 compared to control TAC group. Each data point represents a biologically independent sample.



Figure S7 (related to Figures 5-6). β-integrin mediated macrophage-cardiomyocyte interaction, TRPV4 expression, and TRPV4 activity in cardiac macrophages. A-B, Quantification of the percent of macrophages interacting with cardiomyocytes (A) and macrophage projection length (B) in co-cultures treated with either isotype antibody (vehicle), Itgb1 neutralizing antibody, or Itgb2 neutralizing antibody. C, Quantification of projection length in bone marrow-derived macrophages cultured independently in the presence of isotype antibody (vehicle), Itgb1 neutralizing antibody, or Itgb2 neutralizing antibody. * denotes p<0.05 compared to control (AVOVA, post-hoc Tukey). D, CD68 (red) and Paxillin (white) immunostaining showing loss of Paxillin expression in cultured macrophages treated with the neutralizing ltgb1 antibody. Blue-DAPI. Scale bar 20um. Representative images from 4 independent experiments. * denotes p<0.05 compared to vehicle control (Mann-Whitney test). Each data point in A-C represents information compiled from 4 experimental replicates. Experiments were repeated 4 times and all data was incorporated into the displayed graphs. E. Flow cytometry of *Trpv4-GFP* BAC transgenic hearts showing GFP expression in leukocytes (CD45⁺), endothelial cells (CD31⁺CD45⁻), neutrophils (Ly6G⁺CD64⁻), and macrophages (CD64⁺Ly6G⁻). Percentages of each cell type as a function of the number of GFP⁺ cells is shown. F, Histograms showing GFP mean florescent intensity of CD45⁺ leukocytes, CD31⁺CD45⁻ endothelial cells, MEFSK4⁺CD45⁻CD31⁻ fibroblasts, Ly6C^{hi} monocytes, CD64⁺Ly6C^{lo} macrophages, and Ly6G⁺ neutrophils isolated from littermate controls (grey) and *Trpv4-GFP* (green) hearts. Percentages of GFP⁺ leukocytes and endothelial cells are shown as a function of total number of leukocytes and endothelial cells, respectively. Data obtained from 3 independent experiments. G-H, Ratiometric calcium assays showing that CCR2⁻ (C) and CCR2⁺ (D) macrophages isolated from the adult mouse heart by flow cytometry express active TRPV4 channels. GSK101: TRPV4 agonist, Ionomycin: calcium ionophore.I-J, Ratiometric calcium assays showing that the TRPV4 antagonist (GSK219) blocks rises in intracellular calcium induced by GSK101 in cardiac CCR2⁻ (E) and CCR2⁺ (F) macrophages. Each tracing represents an independently analyzed cell. Tracings were compiled from 3 independent experiments. K, Trpv4 mRNA expression in CCR2⁻ and CCR2⁺ cardiac macrophages. RNAseq data derived from Immgen (Immunological Genome, 2020). CPM: counts per million. * denotes p<0.05 compared to CCR2⁺ macrophages (Mann-Whitney test). Data obtained from 5 biologically independent samples per experimental group.

	Control	Tnnt2 ^{4K210/4K210}
Fractional shortening (%)		
7 days	48.7 ± 3.4	$28.6 \pm 3.4^*$
14 days	50.6 ± 3.1	$26.0 \pm 5.5^*$
28 days	60.7 ± 3.6	$30.5 \pm 2.9^*$
8 weeks	52.1 ± 1.3	21.9 ± 3.7*
16 weeks	53.1 ± 2.1	$14.2 \pm 4.7^*$
LV diastolic dimension (µm)		
7 days	2.12 ± 0.12	2.18 ± 0.16
14 days	2.28 ± 0.12	2.81 ± 0.23*
28 days	2.77 ± 0.33	3.78 ± 0.27**
8 weeks	3.11 ± 0.44	4.38 ± 0.40**
16 weeks	2.90 ± 0.47	4.39 ± 0.46*
Relative wall thickness		
7 days	0.48 ± 0.08	0.43 ± 0.03
14 days	0.47 ± 0.05	0.49 ± 0.03
28 days	0.60 ± 0.14	$0.40 \pm 0.04^*$
8 weeks	0.64 ± 0.10	$0.45 \pm 0.04^*$
16 weeks	0.64 ± 0.10	0.47 ± 0.06*
LV mass (mg)		
7 days	21.9 ± 2.9	21.4 ± 5.1
14 days	26.7 ± 3.7	53.0 ± 11.7*
28 days	65.9 ± 4.9	98.3 ± 15.6**
8 weeks	104.5 ± 20.8	179.2 ± 34.1**
16 weeks	98.7 ± 17.6	173.8 ± 29.5*

Table S1. (related to Figure 1) Serial echocardiography of Control and *Tnnt2^{ΔK210/ΔK210}* mice

* denotes p<0.05 compared to control, ** denotes p<0.05 compared to earlier $Tnnt2^{\Delta K210/\Delta K210}$ groups (ANOVA, post-hoc Tukey). n=5-6 per experimental group. LV: left ventricle. Mean values and standard deviations are displayed.

Table S2. (related to Figure 2) Serum chemistries, cytokines, blood counts, and organweights of control, CD169-DTR, Tnnt2 $^{4K210/4K210}$, and Tnnt2 $^{4K210/4K210}$ CD169-DTR mice

	Control		Tnnt2 ^{4K210/4K210}	
	-	CD169-DTR	-	CD169-DTR
BUN (mg)/dL	44.7 ± 7.2	41.6 ± 4.8	40.7 ± 4.8	45.2 ± 5.8
Creatinine (mg/dL)	0.55 ± 0.08	0.51 ± 0.1	0.62 ± 0.07	0.63 ± 0.1
Calcium (mg/dL)	9.3 ± 0.9	10.0 ± 0.7	10.0 ± 0.6	10.4 ± 1.3
Protein (g/dL)	5.5 ± 0.7	5.5 ± 0.7	5.2 ± 0.6	6.0 ± 0.5
Bilirubin (mg/dL)	0.11 ± 0.06	0.13 ± 0.1	0.10 ± 0.06	0.14 ± 0.1
ALT (units/L)	94.7 ± 25	86.0 ± 34	78.4 ± 20	101 ± 31
TNF (ng/μl)	16.0 ± 2.4	15.9 ± 3.2	22.0 ± 3.1*	22.8 ± 4.2*
IL1β (ng/μl)	9.9 ± 1.4	8.7 ± 1.8	14.1 ± 2.6*	11.7 ± 2.9*
WBC (x10 ³ /µl)	14.3 ± 2.0	12.2 ± 1.5	13.9 ± 2.0	12.0 ± 1.4
Hemoglobin (g/dL)	14.6 ± 1.5	14.0 ± 1.9	14.7 ± 1.4	14.2 ± 1.8
Platelets (x10 ³ /µl)	893 ± 106	874 ± 190	1011 ± 183	1097 ± 207
Heart/body weight	6.1 ± 0.4	5.5 ± 0.3	9.3 ± 1.3*	10.6 ± 2.8*
Lung/body weight	9.0 ± 1.4	9.4 ± 1.5	8.2 ± 1.3	9.9 ± 1.7

* denotes p<0.05 compared to control groups (ANOVA, post-hoc Tukey). n=5-9 per experimental group. ALT: alanine aminotransferase. Mean values and standard deviations are displayed.

	Control		Tnnt2 ^{4K210/4K210}	
	-	CD169-DTR	-	CD169-DTR
Heart rate (beats/minute)				
baseline	266 ± 52	260 ± 72	273 ± 71	308 ± 73
4 ng/min	302 ± 68	288 ± 91	264 ± 54	323 ± 92
8 ng/min	341 ± 103	411 ± 97	330 ± 62	345 ± 84
16 ng/min	505 ± 129	549 ± 30	417 ± 111	484 ± 114
32 ng/min	581 ± 53	621 ± 58	457 ± 122	553 ± 68
64 ng/min	614 ± 38	615 ± 22	554 ± 44	582 ± 58
dP/dt max. (mmHg/sec)				
baseline	5586 ± 1184	5249 ± 1201	1871 ± 490*	2018 ± 778*
4 ng/min	7595 ± 1961	7451 ± 2295	1858 ± 652*	3016 ± 1323*
8 ng/min	11224 ± 2313	11044 ± 2780	4021 ± 1837*	4726 ± 1455*
16 ng/min	16206 ± 1851	15292 ± 1833	4832 ± 1993*	7083 ± 1694*
32 ng/min	17758 ± 1515	17013 ± 2142	5685 ± 2135*	8070 ± 1692*
64 ng/min	17686 ± 1601	18049 ± 1752	7464 ± 2790*	8918 ± 1828*
dP/dt min. (mmHg/sec)				
baseline	-5588 ± 1044	-5236 ± 1134	-2266 ± 637*	-2487 ± 1213*
4 ng/min	-7084 ± 1848	-7374 ± 2487	-2312 ± 954*	-4398 ± 1746*
8 ng/min	-9481 ± 2146	-9599 ± 3043	-5204 ± 2250*	-6529 ± 1572*
16 ng/min	-12926 ± 1713	-11558 ± 2533	-6037 ± 2533*	-8768 ± 1390*
32 ng/min	-12584 ± 1806	-11386 ± 3065	-6841 ± 2255*	-9908 ± 1239
64 ng/min	-12094 ± 2294	-11271 ± 2498	-7855 ± 1911	-10139 ± 1206
LVSP (mmHg)				
baseline	89.1 ± 10	91.4 ± 16	53.7 ± 13	53.7 ± 16
4 ng/min	105 ± 15	107 ± 27	54.4 ± 19	73.7 ± 15
8 ng/min	132 ± 31	114 ± 23	80.1 ± 13	89.5 ± 11
16 ng/min	153 ± 35	130 ± 21	82.9 ± 7.5	95.7 ± 7.5
32 ng/min	155 ± 40	142 ± 31	83.3 ± 6.9	97.2 ± 11
64 ng/min	155 ± 40	147 ± 44	85.8 ± 7.3	101 ± 14
LVEDP (mmHg)				
baseline	7.7 ± 1.4	8.4 ± 2.2	6.8 ± 2.0	5.8 ± 1.4
4 ng/min	9.1 ± 4.1	7.5 ± 2.0	6.2 ± 1.8	7.1 ± 2.1
8 ng/min	7.2 ± 2.6	6.0 ± 1.2	5.6 ± 2.7	8.7 ± 4.5
16 ng/min	5.5 ± 1.9	5.2 ± 1.5	5.2 ± 2.2	7.7 ± 2.7
32 ng/min	4.9 ± 1.2	6.8 ± 5.4	5.5 ± 2.3	8.7 ± 6.0
64 ng/min	6.1 ± 2.4	5.4 ± 2.1	5.2 ± 1.7	8.1 ± 5.5

Table S3. (related to Figure 2) Invasive hemodynamics of control, *CD169-DTR*, $Tnnt2^{\Delta K210/\Delta K210}$, and $Tnnt2^{\Delta K210/\Delta K210}$ *CD169-DTR* mice.

* denotes p<0.05 compared to control groups (ANOVA, post-hoc Tukey). Mice received escalating doses of dobutamine (ng/ml) via intravenous infusion. Measurements were obtained at baseline and indicated dobutamine infusion rates. n=6 per experimental group. dP/dt max: maximum rate of pressure increase, dP/dt min: maximum rate of pressure decease, LVSP: peak LV systolic pressure, LVEDP: LV end diastolic pressure. Mean values and standard deviations are displayed. Data obtained from 9 week old control, *CD169-DTR*, *Tnnt2*^{AK210/AK210}, and *Tnnt2*^{AK210/AK210} *CD169-DTR* hearts after 3 weeks of DT treatment.