Endurance Repeaters – Forearm Aerobic Endurance Hangboard Routine

Jędrzej May 2, 2019 3 Comments

"After 8 weeks of training, my finger strength increased by 17%! Thanks again for your wonderful site and your help selecting a plan! I can't wait to go crush!"

Carson (V8/7B)
Boulderer (US)

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Quick summary

- Principles of modern endurance training

- For best CF improvement train at CF intensity
- Improvements are related to the total work done (TWD)
- A good introduction to hangboard training
- Can be used as a warm-up before a typical hangboard session

Endurance Repeaters – Forearm Aerobic Endurance Hangboard Routine

The Endurance Repeaters Aerobic Endurance Hangboard Routine is a less known modification of the standard 7/3 Hangboard Repeaters strength endurance protocol. Endurance Hangboard Repeaters were discussed by Tom Randall and Ollie Tor in the TBP 114. The idea behind this method is to perform intermittent hangs until failure, with the load reduced to only 30 – 40% of your maximum voluntary contraction (MVC). This makes it a very low-intensity aerobic exercise, which will allow you to build up very slowly towards forearm pump, which is much more similar to what happens on a long endurance route [1].

In endurance sports such as long-distance cycling, running or swimming, endurance is traditionally trained through continuous high-volume (e.g., 60 – 90 minutes) training sessions at relatively low intensity, around 60 – 65% of VO_2max [2]. This kind of training is known to introduce adaptations, which include improved capillary density and vascular conductance, increases in size and density of the mitochondria, aerobic enzymes and fat oxidation, as well as sparing of muscle glycogen, reduced rates of lactate (La-) production and enhanced La- removal, ultimately resulting in improved O_2 supply and thus maximal endurance capacity [3][4][5][6]. Endurance Repeaters are an attempt to apply the traditional endurance training principles to climbing.

Critical Power and the energy store component in aerobic endurance

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solely dependent on a renewable aerobic energy supply. Simply speaking, CP is the maximum power that a muscle can keep up for a very long time without fatigue [7]. You may think of CP as the “maximal aerobic power”, though this particular term (MAP) is used in literature to describe the power output associated with VO_2max [8]. Since in hangboard training, we deal with dead hangs, which involve isometric muscle action, we will use an analogous term of Critical Force (CF) instead of CP. The higher your CF is, the harder you can climb while relying on the aerobic energy system. CF can be given in newtons, but it usually makes more sense to express it as a percent of the climber’s maximum voluntary contraction (MVC).

The second important parameter is the so-called energy store component W’, which indicates the maximum amount of work that can be performed above CF. The energy store component is constant, regardless of the used force, as long as the force is higher than CF. Numerous experiments have shown that CF is determined by the muscle oxidative function, while W’ depends on finite anaerobic energy sources and that it can be manipulated independently, e.g., by altering muscle phosphocreatine (PCr) stores [9]. An example of a hyperbolic force-time relationship for high-intensity exercise is shown in Figure 1. MVC-7 is the 7-second maximum voluntary contraction [N], the asymptote is the CF [N], and the colored rectangles represent the energy store component W’ [N·s], which is constant for each measurement point [10].

It is, therefore, clear that both CF and W’ are critical parameters, which are bound to decide between failure and success on long endurance routes. Recent research showed that while CP can be improved by low-intensity training below CP, as well as by interval training above CP, best results and highest time efficiency are reached when training is done precisely at CP [11]. We can, therefore, assume that Endurance Repeaters should yield the best results if done at CF.

Figure 1: Illustration of the force-time relationship for high intensity exercise, according to [10].

Determination of the Critical Force and W' for aerobic Endurance Hangboard Repeaters

The exact procedure to determine CF and W' by using a hangboard was recently thoroughly described by David Giles, Ollie Torr, Tom Randall, and colleagues [10]. The research team examined eleven 7b – 8b+ climbers. First, they determined each climber's 7-second MVC on a standardized Lattice Training rung (20 mm deep, 10 mm radius) in half crimp position. Then, they performed intermittent dead hang tests until failure at 80%, 60% and 45% of the climbers' respective MVC. They found a hyperbolic relationship between the load at which the test was taken and the time to exhaustion (TTE), which is in agreement with general training theory [12].

The research team determined the CF of the tested climbers to lie between 31.9 – 60% of their MVC, with an average of 41.0 ± 6.2%. What is interesting is that the CF does not seem to depend on the MVC. The climber with the lowest MVC of 121.7% BM (898.8 N) had the second-highest relative CF of 53.5% MVC (480.8 N), while the strongest climber, with an MVC of 183.0% BM (1199.3 N) had a CF of 40.6% MVC (486.4 N), which was below average. In absolute terms that's only 5.6 N, or 0.57 kg difference. The above result explains why you often see relatively weak climbers breeze up through endurance routes, while very strong boulderers, with good strength endurance, struggle after just a couple of meters.

The mean W' found for the examined climbers was 30882 ± 11820 N·s, meaning that on average a 7b – 8b+ climber can operate at, e.g., 500 N load for about 38 – 85 seconds, if of course 500 N lies above their respective CF. Think of it as climbing through a crux sequence – once W' is depleted, you will fall, and it will take about 20 – 25 minutes to fully recover [10].

Critical Force Calculator for optimum aerobic endurance hangboard training

To determine your Critical Force, you can use the calculator below. Input your body weight and your 7-second MVC on a 20 mm edge, followed by respective times to failure for the 7/3 Endurance Repeaters at 80% MVC-7 and 60% MVC-7. For the last measurement you may choose 45%, 50% or 55% MVC-7 load, just make sure that you fail in under 1200 seconds.

The calculator will output your CF and the weight you need to subtract in order to exercise exactly at CF load. You will also receive a brief assessment of your strength and aerobic endurance. The calculator is calibrated for the half crimp grip on a 20 mm edge, to enable a direct comparison with the results published in [10]. The bouldering level prediction is based on the results of the survey published at [13].

Input

kg ◉ lbs ○

BW [kg]: Your Body Weight...

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T(80%) [s]: Your T(80%)...

T(60%) [s]: Your T(60%)...

T(45%) [s] ◉
T(50%) [s] ○
T(55%) [s] ○

Your T(45%/50%/55%)...

Calculate

Results

Calibrated for the half crimp grip on a 20 mm test edge.

MVC-7 [N]: Your MVC-7...

MVC-7/BW [%]: Your calculated MVC-7/BW...

CF [N]: Your calculated CF...

Weight correction [kg]: Weight correction to reach CF...

CF/BW [%]: Your calculated CF/BW...

CF/MVC-7 [%]: Your calculated CF/MVC-7...

W' [N·s]: Your calculated W'...

Bouldering level: Your predicted bouldering level...

Comment: Your personal assessment result...

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Endurance Hangboard Repeaters protocol details

1. Choose two to four grip positions that you want to train.
2. For each grip position, determine your 7-second maximum hang weight (MVC).
3. For each grip position, determine the load at which you are going to train.
   - You can use 25 – 60% of your MVC for the given grip position.
   - For best results, for each grip position, determine and use your CF.
4. Repeat: hang for 7 seconds, rest for 3 seconds until failure.
5. Rest for 10 – 30 minutes.
6. Perform a total of two to four sets, one set per grip position.

Table 1: Endurance Hangboard Repeaters protocol summary.

Endurance Repeaters	
Hang test time [s]	7
MVC-7 load (beginner)	25 - 35% (or CF)
MVC-7 load (advanced)	40 - 60% (or CF)
Sets	2 - 4
Hangs/Set	60 - 120
Hang time [s]	7
Rest betw. hangs [s]	3
Rest betw. sets [min]	10 - 30
TUT [min]	14 - 56
Total time [min]	30 - 170

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- If you keep the intensity below or exactly at your CF, the Endurance Repeaters are only mildly discomforting. As soon as you exceed the CF, get ready for some serious pain!
- Failure means that you are unable to maintain good form anymore, e.g., your elbows are chicken-winging or you can't keep tension in your shoulders.
- Approximate load determination:
  - Determine your 7-second MVC load on the grip position you plan to train.
  - If you think your endurance is poor, perform the exercise at 30 – 35% of your MVC load on a given grip position.
  - If you think your endurance is good, perform the exercise at 40 – 45% of your MVC load on a given grip position.
  - If failure is reached before 20 minutes, decrease the load by 5% of your MVC.
- For best CF improvements and maximized time efficiency train exactly at your CF.
- To determine your CF:
  - For each grip position complete three sets of Endurance Repeaters at 80%, 60% and 45% of your 7-second MVC load, and write down the time till exhaustion (TTE) for each set.
  - Calculate your CF for each grip position based on the method described in [10].
- Improvements in CF seem to be related to the total work done (TWD), so try to make each set last at least 20 minutes [11].
- Six-week microcycle:
  - Train three times per week – 18 sessions in total.
  - Increase the load by 5% after sessions 6, 10, and 14.

Endurance Repeaters – Aerobic Endurance Hangboard Routine results and discussion

From numerous studies, we know that there is a correlation between strength and strength endurance [14][15][16]. Strength depends on the anaerobic alactic energy system, and strength endurance depends on the anaerobic lactic energy system [17][18]. However, aerobic endurance seems to be independent of the first two energy systems, and rely mostly on the forearm muscle oxidative capacity index [19].

The high oxidative capacity index was found to distinguish climbers from non-climbers, but until now no significant differences were found between boulderers and lead climbers. However, to date, all tests were typically performed at fixed 40% and 60% MVC loads [20]. This may have distorted the results, since the tested climbers exercised at various aerobic metabolic intensity domains, below or above their CF. Thus it is suggested that CF should be used for the determination of relative exercise

Based on her research Kerri McGawley suggested that training at CP, which involves significantly shorter-duration training sessions compared with training below and intermittently around CP (for the same TWD), provides “more bang for your buck” in terms of fitness gains per time spent exercising. She observed CP improvements of up to 24% after six weeks of cycling training at CP. What is more, the gains seem to depend on the TWD, so the longer you train, the better results you get. Of course, even at CP, no exercise can be performed indefinitely, as fatigue will eventually ensue, because of, e.g., substrate depletion, dehydration, hyperthermia or sleep deprivation. Furthermore, given the requirement for anaerobic energy provision at the onset of exercise, exercise at CP is never fuelled solely by aerobic metabolism, and it will eventually lead to W’ depletion [11]. Still, completing a 20-minute Endurance Repeaters set should be generally possible, provided that CF was determined correctly.

> *For best results, execute Endurance Repeaters exactly at CF intensity and try to maximize the total work done.*

The rest interval between sets will depend on how much your energy store component was depleted. Recovery after non-exhaustive exercise can occur in roughly 10 minutes, but after exhaustive exercise, 15 minutes was shown to be enough to recover W’ to only 86% [21][22]. One potential theory is that the reconstitution of W’ is exponential, with a time constant of ~377 s, suggesting a recovery duration of 25 minutes is required [10][23]. If you feel pumped after a 20-minute set, and you want to stay on the safe side, you can even go for 30 minutes rest – TWD at CP is the key, and it won’t hurt your gains if you rest for a bit too long.

Endurance Repeaters are an interesting protocol that can serve as a regular drill to creating a solid base for long endurance climbs. Since it is a low-intensity exercise, it can be a very good introduction to hangboarding for novice climbers, or a warm-up routine before a hangboarding or bouldering session. The developed mathematical model is handy for the determination of the optimum load at which to train aerobic endurance, without unnecessarily stressing the climber. It is possible to easily and accurately calculate the time to failure at a given load, as well as the load required to reach failure at a prescribed time [10].

If you ha uestions or comments, feel free to contact me. Please subscribe to the blog, to

References

1. N. Quinn, Lattice Training – 5 Training Hacks for The Time-Poor Climber, Trainingbeta Podcast 114, Oct. 10th, 2018. (link)↩
2. Yamagishi, T., Babraj, J., 2019. Active Recovery Induces Greater Endurance Adaptations When Performing Sprint Interval Training. Journal of Strength and Conditioning Research 33, 922–930. (link)↩
3. Daussin, F.N., Zoll, J., Dufour, S.P., Ponsot, E., Lonsdorfer-Wolf, E., Doutreleau, S., Mettauer, B., Piquard, F., Geny, B., Richard, R., 2008. Effect of interval versus continuous training on cardiorespiratory and mitochondrial functions: relationship to aerobic performance improvements in sedentary subjects. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology 295, R264–R272. (link)↩
4. Holloszy, J.O., Coyle, E.F., 1984. Adaptations of skeletal muscle to endurance exercise and their metabolic consequences. Journal of Applied Physiology 56, 831–838. (link)↩
5. Laursen, P.B., Jenkins, D.G., 2002. The Scientific Basis for High-Intensity Interval Training. Sports Medicine 32, 53–73. (link)↩
6. Whyte, G. (Ed.), 2006. The physiology of training. London: Elsevier. (link)↩
7. Scherrer, J. & Monod, H.,1960. Le travail musculaire local et la fatigue chez l'homme. Journal of Physiology, 52(2): 419-501. (link)↩
8. Bernard, T., Hausswirth, C., Le Meur, Y., Bignet, F., Dorel, S. & Brisswalter, J.,2009. Distribution of power output during the cycling stage of a triathlon world cup. Medicine and Science in Sports and Exercise, 41(6): 1296-1302. (link)↩
9. Jones, Andrew M et al., 2010. Critical power: implications for determination of VO2max and exercise tolerance. Medicine and science in sports and exercise 42 10: 1876-90. (link)↩
10. Giles, D., Chidley, J.B., Taylor, N., Torr, O., Hadley, J., Randall, T., Fryer, S., 2019. The Determination of Finger-Flexor Critical Force in Rock Climbers. International Journal of Sports Physiology and Performance 1–8. (link)↩↩↩↩↩↩↩↩↩↩
11. McGawley, K., 2010. The application of the critical power construct to endurance exercise. University of Brighton. Student thesis: Doctoral Thesis. (link)↩↩↩
12. Scherrer, J. & Monod, H.,1960. Le travail musculaire local et la fatigue chez l'homme. Journal of Physiology, 52(2): 419-501. (link)↩
13. https://toclimb8a.shinyapps.io/maxtograde/ (link)↩
14. López-Rivera, E., González-Badillo, J.J., 2019. Comparison of the Effects of Three Hangboard Strength and Endurance Training Programs on Grip Endurance in Sport Climbers. Journal of Human Kinetics 66, 183–195. (link)↩
15. Bergua, P., Montero-Marin, J., Gomez-Bruton, A., Casajús, J.A., 2018. Hanging ability in climbing: an approach by finger hangs on adjusted depth edges in advanced and elite sport climbers. International Journal of Performance Analysis in Sport 18, 437–450. (link)↩
16. Stone, M. H., Stone, M. E., Sands, W. A., Pierce, K. C., Newton, R. U., Haff, G. G., & Carlock, J. (2006). Maximum strength and strength training. A relationship to endurance? Strength &Conditioning Journal, 28(3), 44–53. (link)↩
17. N. Quinn, Steve Bechtel on Training Endurance for Climbing, Trainingbeta Podcast 110, Aug. 9th, 2018. (link)↩
18. E. Hörst, Maximum Strength Fingerboard Training, T4C Podcast #10: Mar. 1st, 2017. (link) ↩
19. Fryer, S., Stoner, L., Stone, K., Giles, D., Sveen, J., Garrido, I., España-Romero, V., 2016. Forearm muscle oxidative capacity index predicts sport rock-climbing performance. European Journal of Applied Physiology 116, 1479–1484. (link)↩
20. Fryer, S., Stone, K.J., Sveen, J., Dickson, T., España-Romero, V., Giles, D., Baláš, J., Stoner, L., Draper, N., 2017. Differences in forearm strength, endurance, and hemodynamic kinetics between male boulderers and lead rock climbers. European Journal of Sport Science 17, 1177–1183. (link)↩
21. Vanhatalo, A., Jones, A.M., 2009. Influence of prior sprint exercise on the parameters of the "all-out critical power test" in men. Experimental Physiology 94, 255–263. (link)↩
22. Ferguson, C., Rossiter, H.B., Whipp, B.J., Cathcart, A.J., Murgatroyd, S.R., Ward, S.A., 2010. Effect of recovery duration from prior exha ise on the parameters of the power-duration relationship. Journal of Applied Physiology 108, 866–874.

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above Critical Power. Medicine & Science in Sports & Exercise 44, 1526–1532. (link)

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About the author

Jędrzej

A veteran hangboarder and a Moonboard fan, Jędrzej is crazy about training for climbing. There's nothing he likes more than trying out different protocols and applying the newly acquired skills on the wall. Jędrzej also enjoys playing the electric guitar, baduk, and reading articles on the science of sports training. He holds a Ph.D. in electrical engineering.

EVA LÓPEZ MAXHANGS HANGBOARD ROU... CLIMBING CRITICAL FORCE CALCULATOR

3 thoughts on "Endurance Repeaters – Forearm Aerobic Endurance Hangboard Routine"

THOMAS
JANUARY 10, 2021 AT 6:11 PM

Hi Jedrzej,
awesome and very interessting homepage. Great job! I tried to find out my CF (may I did something wrong)
My results: bodyweight 75 kg, MVC-7 = 17 kg, T80 = 61 Sec., T60 = 154 Sec., T55 = 294 Sec.
What is now my CF? Should I train with a 8,3 kg assistance?

I`m a lead climber since 13 years. I climb around 7b+ – 7c. I did one 8a 2 years ago. But i never did a fingerboard training and the 20 mm edge felt very strange – so maybe this is the reason for my bad results :)

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Best regards and thanks for your work 🙂
Thomas

Reply

JĘDRZEJ
JANUARY 10, 2021 AT 8:39 PM

Hi Thomas!
Thanks for your comment! I'm delighted that you enjoy the site! I took a look at the numbers you provided. You said that your MVC-7 on a 20 mm edge is 17 kg, but I believe that that's your added load, right? That would make it 92 kg altogether. Is that correct? I also assumed that the data you provided is the TUT (Time Under Tension). If you input these numbers into the Critical Force Calculator Tool on my site, your calculated CF is 439.2 N (44.8 kg). That means that to best train your aerobic endurance, you should reduce your weight by 30 kg.

In terms of climbing grade prediction, your result is lower end 7c+, but you probably do best on long endurance routes. You're not very strong (MVC-7 is 122.7% BW), but you compensate with pretty good aerobic endurance. If you want to progress quickly, focus on increasing your MVC-7. If you can increase it to 100 kg and maintain your current endurance times, you should comfortably project long 8a endurance routes.
Let me know if this makes sense to you!
Cheers,
Jędrzej

Reply

THOMAS
JANUARY 12, 2021 AT 7:44 AM

Ok. thanks for your fast reply. I will focus on my MVC-7 with max-hangs.
Cheers,
Thomas

Reply

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