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# A novel tool and training methodology for improving finger strength in rock climbers

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**Abstract**

Recently a novel finger strength training tool for rock climbers, the Rock Prodigy Training Center (RPTC) and its associated training protocol, the Rock Prodigy Method (RPM) were developed. The RPTC incorporates several innovations that improve upon similar, traditional devices to provide a sport-specific, repeatable method for improving finger strength in climbers, and to improve overall climbing performance. After several months of use by climbers around the world, the efficacies of these tools were evaluated by comparing pre- and post-training climbing performance. Training and performance data are presented from 118 athletes which clearly demonstrate that the RPTC and RPM are highly effective at increasing sport-specific finger strength. Finger strength improved an average of 21.5% after only 4 weeks of training, and overall climbing ability improved an average of 2.5 Yosemite Decimal System letter grades after using these training tools.


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*Keywords:* Rock climbing performance; finger strength training; hangboard design; rock prodigy training center; rock prodigy method

## 1. Introduction

In 2013 a new tool for developing finger strength in rock climbers, The Rock Prodigy Training Center (RPTC) 0, was introduced along with a book describing training techniques. The RPTC is a hangboard training device (Fig. 1) which climbers use to develop finger strength by hanging from the board's various grips. These grips are designed to simulate natural rock climbing holds, and apply sport-specific stimulation to the finger flexor systems to develop

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strength. Numerous studies indicate that sport-specific finger strength is a substantial contributor to overall climbing performance, and finger strength gains will generally translate to improved rock climbing performance 0-0.

Along with the RPTC, a training instruction book, The Rock Climber's Training Manual*: A Guide to Continuous Improvement* 0 was published by the authors presenting a recommended training methodology for the RPTC that is based on sports science. This Rock Prodigy Method (RPM) uses linear periodization to build fitness through a variety of exercises (including hangboard training). In this paper, the efficacy of the RPTC and RPM are evaluated by comparing pre- and post-training performance. Performance is quantified in terms of both finger strength training intensity and overall climbing performance. Data is from multiple athletes with a range of training experience.

## 2. Background: Finger strength training for rock climbing

### *2.1. Finger strength training on a hangboard*

Hangboard training is an effective method for improving finger strength in climbers because it is possible to control and track many training variables such as grip type, resistance, and exercise duration 0. This is in contrast to other climbing exercises such as unstructured climbing or bouldering, wherein resistance and duration are difficult to control. Further, hangboard training is more sport-specific than other finger strength training methods, such as spring-loaded compression devices. A training device often used by climbers is the *campus board*, an inclined wall with columns of climbing rungs that climbers hang from, and then climb up the board dynamically, without using their feet. Campusing is a plyometric exercise, and is effective for developing muscular power and coordination 0, 0 but it is not ideal for strength training because it is less-controlled, and only utilizes one grip position. Another tool used by climbers is a "turn-till-burn", which is similar to "heavy finger rolls". It is a pull-up bar that is free to rotate, requiring the climber to perform finger curls until failure. Unfortunately, there is no evidence in the literature that this tool has been evaluated through research.

Hangboard exercises consist of static two-arm "dead-hangs" (Fig. 2 - left) in which both hands are used on the board at all times — with each hand on the same size and type of grip for a given set. The elbows and shoulders are slightly bent and the muscles of the upper arm, shoulder, and upper back should be flexed during each hang to support the athlete's weight. The athlete does not pull-up, or otherwise vary the body position during the repetition.

Each workout entails several sets of hangs of a set duration from a premeditated sequence of climbing-grip positions. A repetition begins when the legs are slowly lifted off the ground, thus weighting the fingers, and ends when the feet return to the ground. The exercise intensity can be tuned (increased or decreased) by hanging supplemental weights from the athlete's harness (Fig. 2 - center), or by attaching a weighted pulley system that assists the athlete (Fig. 2 - right). This weight is also used to quantify the athlete's finger strength, and has been shown to be a more reliable metric than hand dynamometers for measuring climbing-relevant finger strength 0.

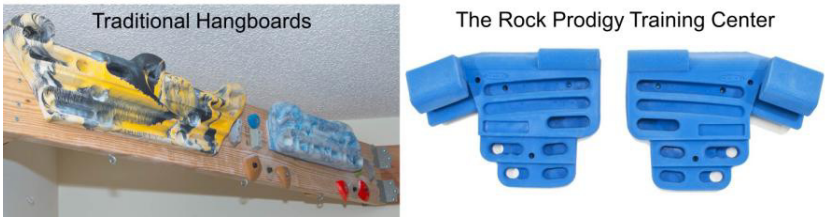


Fig. 1. Traditional hangboard designs (left), used to develop finger strength in rock climbers: Metolius Simulator (far left), and Nicros NexGen (center-left). The Rock Prodigy Training Center (RPTC) is on the right, and represents a significant departure from traditional designs.

### *2.2. Deficiencies of traditional hangboard designs*

Traditional hangboards (Fig. 1 - Left) are a single piece with symmetric arrangements of holds. They are often designed for marketability rather than climbing-specific finger strength training. Hangboard training often leads to overuse injuries including shoulder, elbow, and wrist tendonitis, as well as injuries in the systems that enable finger

flexion (to include the finger flexor and extensor muscles in the forearm, finger flexor tendons, annular pulleys in the fingers, and the interphalangeal joints in the fingers 0). These overuse injuries may be a result of the traditional, single piece, symmetric hangboard design. During a hang, the athlete grips matching pairs of holds, which are equidistant from the board's centerline. As a result, certain grip pairs may force the athlete's hands close together or far apart – neither of which are ergonomic positions – placing extra stress on the athlete's joints.

The most common hangboard-related injuries are skin injuries to the finger pads caused by friction between the skin and hangboard. These may be blisters, tears, or general soreness. While minor compared to structural injuries, skin injuries are very common due to the high shear and normal stress applied to the skin. When sustained, the athlete will be unable to continue training the responsible grip position at the same intensity until the skin heals (~5 - 15 days). Therefore, skin injuries can greatly impede training. Hangboards that were not designed for high-intensity training may have grip shapes that concentrate stress on the skin and increase the risk of skin injuries.

Finally, traditional hangboards are usually created by hand, by a designer who crafts a mold from which production models are formed. Thus, the products are not highly repeatable, nor easily refined.

Fig. 2. The RPTC in use, demonstrating the "two arm dead hang (left)," and using weights to tune exercise intensity. In the center, intensity is increased by attaching weights to a harness worn by the athlete. On the right, intensity is decreased by weights acting through a pulley system.

## 3. Design of the Rock Prodigy Training Center

The development of the RPTC (Fig. 1- right) was a departure from previous hangboards (Fig. 1- left) in that it is an engineered system, designed for elite finger strength training, based on analysis and 18 years of training and experimentation by the designers. The project goals were to create a training tool that: 1) improves finger strength in rock climbers, 2) improves rock climbing performance and 3) is more ergonomic than previous hangboard designs. An underlying premise is that a more ergonomic design would enable athletes to perform higher-intensity exercises without developing injuries. Therefore, a more ergonomic design would enable more effective training, and would thus accomplish goals 1 and 2.

The design goals were to 1) increase ergonomics, 2) eliminate skin stress concentrations, 3) reduce unused material in the center of the board and 4) increase grip specificity to natural rock climbing holds. The design process included biometric analysis, 3D computer modeling, rapid prototyping, and testing in an iterative process to refine hold configurations and shapes. Finally, a computer-aided manufacturing process was used to ensure accurate reproduction of the models, and facilitate design refinement. The resulting product includes many innovations:

- Two piece design (one hangboard for each hand) for adjustable hand spacing and rotation.
- Angled grips that track arm rotation and improve shoulder, elbow, and wrist ergonomics.
- Sets of related grips of progressively increasing difficulty
- Rotated pinch grips that provide a natural grip position for improved ergonomics.

The two-piece hangboard design is the major innovation of the RPTC. When fastened to an adjustable, sliding mount 0, it allows the athlete to position their hands shoulder-width apart for every grip, regardless of the grip's location on the hangboard. This provides the most natural and ergonomic hanging position, and thus reduces

unnecessary stress on the wrist, elbow and shoulder joints, which are under considerable stress for the duration of the workout (400+ high intensity repetitions per workout). The two piece design also enables the athlete to rotate each half of the board independently to create the most ergonomic position for any given grip. While the two-piece hangboard design may seem intuitive or "obvious", nearly four decades of hangboards leading up to the RPTC did not include this feature.

## 4. Rock Prodigy Method

The RPM is the recommended training methodology for the RPTC. It uses linear periodization to build finger and overall body climbing fitness over a roughly 12 week training cycle, resulting in a performance peak lasting 4 – 6 weeks. These training phases are Base Fitness, Strength, Power, and Power Endurance (Fig. 3). The foundation of the RPM is the Strength Phase, which is responsible for long-term improvement over years of training. It focuses on finger strength training on a hangboard, but strength exercises targeting other muscle groups are prescribed as well. The Base Fitness phase consists of anaerobic threshold training 0. The Power phase consists of high intensity, dynamic exercises such as Limit Bouldering and Campusing. The Power Endurance phase consists of moderate to high intensity interval training. The reader is encouraged to consult the Rock Climber's Training Manual or www.rockclimberstrainingmanual.com for more details 0.

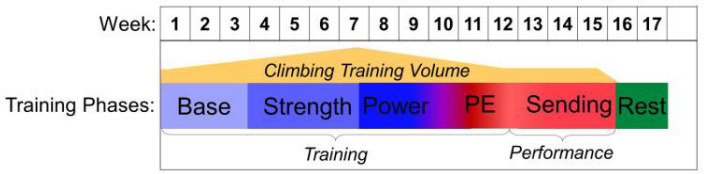


Fig. 3. Example RPM training cycle which uses linear periodization consisting of four distinct training phases over 12 weeks, followed by a 4-6 week performance phase.

## 5. Methods: Evaluation of the RPTC and RPM

The overarching project goal was to develop a new tool to facilitate elite finger strength training according to the Rock Prodigy Method (RPM), and thus, improve overall climbing performance in rock climbers. An innovative hangboard was designed and produced, which has been available and in use by climbers since September 2013. Based on the deliberate design process, it is hypothesized that the RPTC, when used according to the RPM will provide finger strength improvements, and lead to improved climbing performance. This hypothesis was evaluated by collecting performance data from over one hundred RPM and RPTC users.

A 61-question survey was posted to the author's website 0 and visitors were encouraged to take the survey on a purely voluntary and anonymous basis. Therefore, the study population is limited to individuals who have visited the website, and is not inclusive of all RPM or RPTC users. Some bias may be inherent in this survey process. A control group was not used, but respondents were asked to provide performance data prior to using the RPM and RPTC which serves as the control for this evaluation.

Climbing ability is quantified by the most difficult route the respondent has successfully climbed. Climbing routes are given a community-consensus numerical grade, which each respondent reported. A numeric scale was assigned to each grade to quantify climbing ability and more easily evaluate the RPM and RPTC.

## 6. Results

The survey was completed by 118 respondents, though some did not answer every question. Respondents were from 13 countries, had an average of 10.6 years of climbing experience, and were 94% male. Sixty-nine percent of respondents indicated they followed 75% or more of the prescribed RPM workouts. Demographic data was collected to establish each respondent's climbing and training experience, as well as their climbing ability prior to using the

RPM and RPTC. The data indicated that climbing ability is not well-predicted by factors such as years of climbing experience, frequency of climbing or training, or use of a systematic training program as reported by the respondents (linear regressions of these relationships $R^2$ values less than 0.1). This is typical for many climbers who have climbed for decades, but have not made significant improvement over that time. This is evidence of the general lack of effective training protocols and tools, and lack of willingness of some climbers to stick to a training program.

The first goal of the project was to develop a tool (RPTC) and method (RPM) to improve finger strength in rock climbers. Respondents recorded their *weight hanging ability* (WHA – their body weight plus/minus any added/subtracted weight) on specific RPTC grips during hangboard workouts that were performed as part of the linear-periodic training season (Fig. 3). All respondents experienced significant increases in WHA, and thus, finger strength for virtually all grips that were trained. The mean finger strength gain across all respondents and grips was 26.1 lbs (*N = 158 grips*) after one, 4-week training phase (totaling 8-10 workouts) and 38.3 lbs (*N = 73 grips*) after multiple 4-week training phases. These are 21.5% and 32.0% increases in finger strength, respectively.

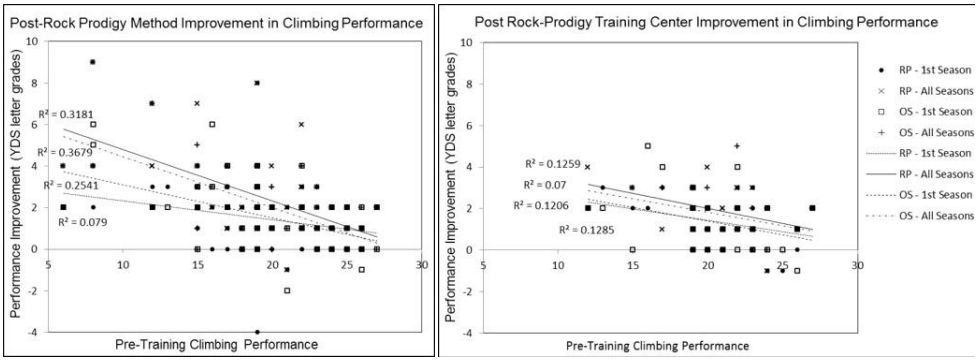


Fig. 4. Reported improvement in Red Point (RP) and On Sight (OS) climbing ability after using the RPM (left) and RPTC (right) for one season, and after multiple seasons, in units of climbing rating "letter-grades".

Table 1. Climbing performance improvements as a result of RPM and RPTC training from all study respondents in units of YDS letter grades.

| | Mean Increase in Hardest Climb Rating: | | | | Qualitative Assessment: | | |
|---|---|---|---|---|---|---|---|
| | 1st Season | | All Seasons | | How has the RMP/RPTC changed your performance? | | |
| Training Tool | Redpoint | Onsight | Redpoint | Onsight | No Change | Slightly Improved | Significantly Improved |
| Post-RPM Training: | 1.44 | 1.51 | 2.50 | 2.03 | 4.7% | 38.3% | 57.0% |
| Post-RPTC Training: | 1.35 | 1.29 | 1.96 | 1.72 | 7.7% | 4.5% | 50.8% |

Clearly, training on the RPTC with the RPM substantially increases finger strength in climbers. Next, the impacts of the RPM and RPTC on overall climbing performance were examined. Fig. 4 shows improvement in Red Point (RP) and On Sight (OS) climbing performance after training. Climbing performance is quantified by the Yosemite Decimal System (YDS) grade rating of the hardest climb the respondent was able to complete during the 4-6 week performance phase following training. This is compared to the respondent's previous hardest climb to calculate improvement in units of YDS letter-grades. Improvement totals vary between use of the RPM and RPTC because a given respondent may follow the RPM, but did not use the RPTC, or they started using it at different times.

Mean improvements in climbing performance across all respondents are summarized in

Table 1. Respondents reported a mean increase in Red Point climbing performance of 1.44 and 1.35 letter grades after their first season using the RPM and RPTC, respectively (all means passed the paired two sample t-test and are statistically significant at the 0.0001 level). In the sport of climbing, these are remarkable rates of improvement. Recall the demographic data indicated that climbing performance is weakly correlated to experience and it rises at a rate of one YDS letter-grade per decade in the sport. With the RPM, significant improvement occurred after only

one season of training, and continued after multiple seasons (maximum of ~3 seasons, as the RPM was published in Spring 2014).

## 7. Discussion

Such dramatic improvement would be surprising in sports that utilize intensive training programs. However, rock climbers typically resist rigid training programs, and those that do train lack effective, consistent protocols to follow. It is likely that the RPM was effective because it presented an easy-to-follow program that climbers (who are not accustomed to training) could follow and that it was accompanied by research-based evidence of its effectiveness that motivated the climbers to adhere to the program (as noted above). Therefore, the subjects were relatively undertrained, and had high potential to improve with training.

Respondents also gave qualitative assessments of their improvement, which is helpful in a complex sport like rock climbing because improvement from training may not result in climbing a more difficult route in that season. After using the RPM and RPTC, 95.3% and 92.3% of respondents indicated they had improved, respectively. Numerous user comments described these gains, such as climbing a personal-best route in less time or fewer tries, or climbing several such routes in one season. The RPTC was designed to allow users to train harder without injury, and 85% of respondents reported they were indeed able to train harder without fear of injury versus other training methods (64% versus other hangboards). Fewer injuries than other training methods were reported by 74% of users (24% answered “not sure”), while the figure is 53% versus other hangboards (37% not sure).

## 8. Conclusion

The RPTC and RPM are highly effective at improving finger strength and climbing ability in rock climbers. Data indicates that the two-piece design and other features are indeed more ergonomic, allowing athletes to train harder and ultimately improve climbing performance – the most important metric for climbers. This is the largest study yet performed to evaluate finger strength training methods in rock climbers, and it revealed many interesting findings. Still, the increasing number of users of the RPTC and RPM create an opportunity to perform more extensive research into finger strength training methods. The next version of the RPTC is under development, incorporating this research, and its effectiveness will be evaluated, along with the long-term sustainability of strength gains.

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