

**Limb
POWER**
Living life without limbs



RESOURCEGUIDE CYCLING



A Guide to amputee and limb impaired cycling



This guide is for people with an amputation or limb difference, who are thinking about getting back to cycling post injury or learning to cycle for the first time. Cycling is both a social and physical activity requiring little specialist support or coaching, it is also relatively inexpensive. LimbPower hope to provide you with useful information about cycling with or without a prosthesis; the equipment you need to take up cycling and suggestions for training to improve your fitness for cycling. Training programs can help you to learn to cycle in the most energy efficient way and to train and condition your body to minimise the risk of injury.

“Cycling as an amputee gives you a sense of freedom, where you forget about the everyday struggle as an amputee!”

Neal Gibson, The first amputee to compete at the British BMX championships on a 20” Bmx

Cycling is for everyone

British Cycling advocate that “cycling is for everyone” and LimbPower believe that with the vast array of cycles and adaptations on the market, there is no other physical activity that offers a greater opportunity to get active than cycling.

Cycling is a good choice for (re)introduction into physical activities. It is possible to cycle without a bespoke prosthesis and often without the need for a bespoke bike or equipment. However, in some cases adaptation to the socket, prosthetic or bike may be necessary for comfort or mobility. For example, above knee amputees may find their everyday socket makes sitting on the seat uncomfortable and individuals who cycle regularly may wish for a freer swinging knee. This will be dependent on your level of amputation, movement limitations and current level of fitness. If your socket isn't comfortable when you first start cycling, please don't give up because there are many different cycles and many adaptations that can be made to the bike and your socket to improve this. Some above knee and through hip amputees cycle without a prosthesis at all.

Please note: While this guide is extensive, it can never be absolutely definitive.

Please do not attempt to cycle or do any of the exercises in this guide without first speaking to your G.P. or a relevant healthcare professional.

We will not cover wheelchair racing as this is considered a type of athletics and not cycling.

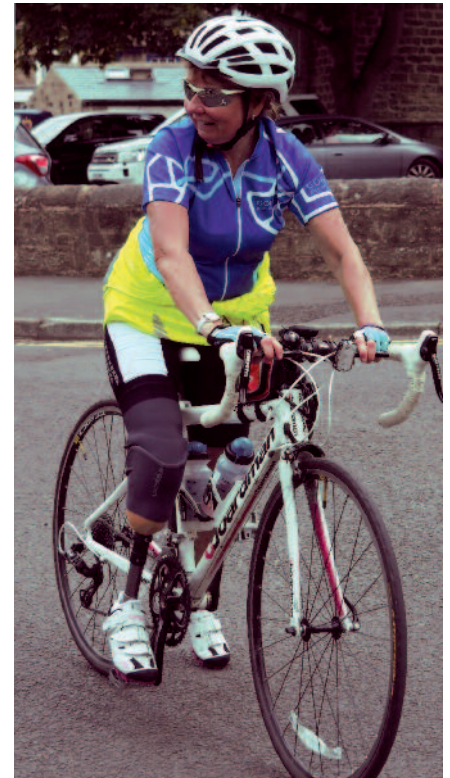
Why Cycle?

Many amputees and individuals with limb difference have reduced mobility and a reduced quality of life as a result of an impairment. Cycling can improve mobility and add value to your quality of life.

- Physical activity improves physical health; circulation, breathing, balance, coordination and flexibility.
- Physical activity improves mental health; relieves depression (through the release of endorphins) and promotes self-esteem.
- Physical activity also has a positive impact on social health; promotes integration, overcomes isolation and improves social skills.

There is a plethora of research that highlights the physical, social and psychological benefits of physical activity and sport. However, we are all aware that getting active isn't always easy, as there are many barriers to overcome.

Cycling is an excellent introductory physical activity for amputees and people with limb difference, improving fitness before moving into other activities. If you are unsure about how you will cope on outdoor terrain, you can begin training on a stationary bicycle and progress as your confidence and comfort improves. Cycling is a non-weight bearing activity so little



stress is placed on the residual limb removing some of the socket and residual limb issues experienced during other physical activity. Amputees and individuals with limb difference can cycle with little risk of injury if they learn the basic cycling skills and are cautious on the road, always wearing a helmet and other protective clothing. Cycling can be an excellent form of low impact aerobic exercise that may feel less physically strenuous than walking, whilst still challenging the cardio vascular system and burning calories.

Cycling is a very accessible sport and easy to adapt to ability, fitness or comfort level. For example, you can cycle on your own and in your own time; you can cycle with or without a prosthesis on; you can cycle with friends or with a club meeting new people and developing friendships or you can cycle indoors at the gym. Cycling gives you a sense of freedom, it is enjoyable and can be exhilarating. According to the recent LimbPower Physical Activity and



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→ Sport survey 2016, cycling is one of the top three physical activities engaged in by amputees and individuals with limb difference.

Types of Cycling

There are many different forms of cycling and adaptive cycling. It always best to try as many different forms as you can until you find one which suits your ability and/or level of amputation. Bicycles, mountain bikes, trikes, handcycles and recumbent bikes can be ridden with or without a prosthesis on and gym bicycles can be adapted to suit most people (spin bikes are better than the old-style gym bikes for above knee amputees). Almost all cyclists will need minor bike adjustments over time, the same

is true for people who use prosthetics or have limb differences.

Learning to Cycle

If your child is an amputee or has limb difference teaching them to cycle is a life skill that will promote self-confidence, independence, social inclusion and reduce feeling of isolation and feeling different, it is also great fun! If your child is in school, find out if they offer Bikeability and discuss with the teacher or cycling coach about their ability and what additional support they may need.

As an adult, it is never too late to learn. The old adage that once you learn to ride a bike, you never forget is true; however, it may take some practice to regain

a previous level of skill. Whether learning to cycle for the first time or returning to a bike, the way you go about doing this depends on both the level of your amputation and your personal choice.

It is important to take time to decide for yourself whether you want to cycle the way you did previously (if applicable) or whether to try an adaptive form of cycling, which may better suit your ability and level of amputation. There are many ways to help inform yourself of the possibilities:

- You can talk to other amputees and individuals with limb difference, as well as healthcare professionals to find out what type of cycling will suit you and your level of amputation.
- You can look for an opportunity to try a variety of bikes by attending a LimbPower Cycling Clinic (normally held at our events, such as the LimbPower Games, The Junior Games, The Manic MaraFun. For further details, go to www.limbpower.com).
- You can attend a British Cycling Disability Hub. All the sessions take place on a traffic free enclosed area which will usually be a closed road circuit. <https://www.britishcycling.org.uk/disabilityhubs?c=EN>
- You may also want to consider joining a club or taking cycling lessons from a qualified instructor. Find a club information <https://www.britishcycling.org.uk/clubfinder?club-search-query=&location-search-by=postcode&distance=&postcode=&homecountry=&showing-more-activities=0&go-ride-club=0&go-ride-club=1?c=EN>
- Find a coach <https://www.britishcycling.org.uk/coachingdirectory>

Safety

Cycling safety is paramount, please follow these simple guidelines:

- **Helmet**
Always wear a helmet (and replace the helmet every 5-10 years or after any impact)
- **Seen and Heard**
Make sure you have working lights for night-time rides and reflective clothing. (Even in the day time being seen is important and a bell can also help prevent accidents)
- **Safe Environment**
Do not ride alongside the road until you are full competent.
- **Route plan**
Make sure you know how you can get to your end point safely and be alert to diversions.

- **Check your bike**
Not only can an un-serviced bike be dangerous you may also find yourself a long way from home with no transport.
- **Highway Code**
Familiarise yourself with this and ensure you are following these regulations.

For more safety tips, please visit: www.nhs.uk/Livewell/getting-started-guides/Pages/getting-started-cycling.aspx



“Cycling for me is a way of getting out and being on a level playing field with the kids on their bikes. It’s great exercise, all inclusive and very good fun.”

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→ Step One

Before embarking on any form of exercise, consult with your GP or healthcare professional at your limb centre. A responsible health care professional will ensure that all the correct people are consulted. They will advise whether you are fit enough to take on the activity and to ensure you are given the right advice on exercises to build up any necessary fitness and muscle strength and the right prosthetic set up is completed and checked.

The first thing you need to know is that you do not need a bespoke or sports prosthesis to cycle. The majority of amputees can cycle whether it be a bicycle, a tricycle or a hand bike. Although you may need to make some minor adaptation to both your bike and your prosthesis to enable safe and comfortable use, this will involve some trial and error. Your health

care specialist will often observe you cycling to enable them to make reasonable adjustments.

Step Two

Now you have been given the all clear to cycle, it is time to build your confidence and fitness. Start cycling in the gym (if you can) on a static bike (gym bike). Gym bikes can be difficult if you are an above knee amputee due to the lack of knee flexion on the prosthesis and the limitations of the socket. Spin bikes are better, more upright and you might even be able to cycle out of the saddle. Improving your fitness in the gym and practicing on a static bike will give you an idea of your personal limitations and the limitations of the prosthesis. Some IFI gyms will also have recumbent static bikes and fixed hand cycle apparatus. For more information, go to <http://www.efds.co.uk/get-active/inclusive-gyms>.

Once you feel confident that you can cycle for five minutes solid without excessive discomfort or pain, you can consider moving onto cycling on your chosen bicycle set-up on a turbo trainer (The wheel driven by the pedals is raised so the bike will not move forward). You can build your fitness gradually while getting used to the bike you will be cycling on outdoors. You can use this as an opportunity to highlight any necessary prosthetic adaptations (foot alignment, knee joint for greater knee flexion, socket shape and type) or bike adaptations (such as foot placement, type of foot attachment, size of crank, seat height and type of saddle) you need to make for safety and comfort. Some people prefer to get straight on a bike, but it is important to have the right set-up. Most quality bike shops will be able to help you choose a bike and set it up correctly. If they haven't worked with an amputee before

Cycling Prosthesis for Lower Limb Amputees

	Below knee	Above knee
Non-limb wearer	No prosthesis required for activity/ prosthesis too restrictive/ or not allowed at competition level	No prosthesis required for activity/ prosthesis too restrictive/ or not allowed at competition level
Lower activity	Standard prosthesis, some modifications such as torsion absorbers are available	Prosthesis too restrictive/ or not allowed at competition level
Medium activity	Standard prosthesis, some modifications such as torsion absorbers are available	Standard prosthesis socket, non-energy storing foot; disengaged hydraulic knee/cycling mode
High activity	Reinforced socket lowered appropriately, non-energy storing foot	Reinforced socket lowered appropriately, disengaged hydraulic knee, non-energy storing foot
Competitive/Specialist <i>(unlikely to be available through the NHS)</i>	Carbon socket with bespoke all in one design or bespoke ankle/foot	Reinforced socket lowered appropriately with specialised cycling knee

Cycling prostheses for Upper Limb Amputees

	Below knee	Above knee
No prosthesis worn	No Prosthesis	No Prosthesis
Lower activity	No Prosthesis	No Prosthesis
	Or Standard or reinforced socket, modular forearm unit with ball and socket or clamp attachment	Or Standard or reinforced socket, lockable elbow, modular forearm unit with ball and socket or clamp attachment • For mountain biking consider hydraulic elbow
Medium activity	No Prosthesis	No Prosthesis
	Or Standard or reinforced socket, modular forearm unit with ball and socket or clamp attachment	Or Standard or reinforced socket, lockable elbow, modular forearm unit with ball and socket or clamp attachment • For mountain biking consider hydraulic elbow
High activity	No Prosthesis	No Prosthesis
	Or Standard or reinforced socket, modular forearm unit with ball and socket or clamp attachment	Or Standard or reinforced socket, lockable elbow, modular forearm unit with ball and socket or clamp attachment • For mountain biking consider hydraulic elbow
Competitive/Specialist <i>(unlikely to be available through the NHS)</i>	• Specialist prosthesis with rigid formed blade/starting block prosthesis Or Standard socket, modular forearm unit with simple attachment	• Specialist prosthesis with rigid formed blade/starting block prosthesis Or Standard socket, modular forearm unit with simple attachment

you can always take this resource with you.

Remember when you first learn to cycle, you should do so in a safe, traffic free place. British Cycling run many disability cycling hubs across the country which are on closed road circuits and run by British Cycling's Go-Ride coaches. There are currently hubs in Manchester, Bath, Nottingham, York, Kent, Leeds and London. London sites include Herne Hill, London Lee Valley Velopark and Stoke Mandeville Stadium in Aylesbury. Read more at www.britishcycling.org.uk/go-ride

If you don't have access to one of these hubs then look for a safe, traffic free area. It is also worth trying cycling with one hand in this safe environment because once you are

on the road, you will need to make clear hand signals whilst maintaining control of the bike.

Step Three – Your Prosthesis

If you are planning to do more than the odd bit of recreational cycling, your prosthesis will need some adjustments. Arrange to take your bike with you to your prosthetist so that they can see what the issues are for themselves. This will help you and your prosthetist ensure your bike and prosthesis are set-up correctly. You can go to a specialist bike shop who will help you to set your bike up to suite your height, build and ability.

Lower-Limb Amputees

If you are a lower limb amputee, you can choose between cycling with or without a prosthesis on. Cycling with a prosthesis on will reduce inter-limb asymmetry, but may require adaptations to the bike and the prosthesis. Cycling without a prosthesis is more difficult, but not impossible. There are a handful of above knee amputees or through hip amputees who have a short residual limb who cycle without wearing a prosthesis. For upright bikes, you can attach the residual limb to the bike using a cuff or sleeve.

If you decide to cycle with the prosthesis on, you may need to consider one of the methods of attachment to secure your



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→ prosthesis to the pedal to avoid movement and the artificial foot slipping off. Different forms of attachment include, straps, cages, mountain bike magnetic pedal locks and spd clips (cleats).

If you are having persistent problems with range of knee motion, you can ask your bike centre about a hinged crank arm. These were specifically developed for amputees with a Van Nes rotationplasty, but can be used by anyone with rotational limitations.

Below Knee Amputees

Below knee amputees can consider adjustments to the back of the socket brim to allow full knee flexion. Lowering the socket brim will make walking more difficult, but will improve cycling performance. Some prosthetists have designed a removable brim, which can be taken off for cycling and replaced for walking. Also consider replacing suspension systems that cross the knee, such as suction sockets with the distal pin-and-lock system. Some amputees cycle with the suspension system and some prefer the pin-and-lock system. You can discuss these different attachment options with your prosthetist.

Above Knee Amputees

Above knee amputees need adequate clearance between the saddle and the socket brim to avoid the socket catching the saddle. The posterior brim of the socket can be trimmed for greater comfort on the bike. Lowering the back of the socket allows for this clearance, but is not suitable for walking long distance. This is a compromise worth discussing with your prosthetist, they may be able to offer you another solution (such as a second socket). For road cycling, a knee that allows free

The right fit of helmet

Your helmet might just save your life, or limit injury in an accident. Store it carefully somewhere it will not get knocked or damaged (if this happens it may need replacing).

Make sure your helmet comes from an official source (such as a bike shop), is of good quality and is not second-hand. When you try it on, ensure that there is two fingers width between your forehead and the brim of the helmet.

Make sure your hair is out of your face before you place the helmet on

your head.

Ensure the straps are not twisted and fasten them under your chin. Tighten the main strap so that no more than one finger may be placed between your chin and the buckle. The buckles of the side straps should sit with the bottom of the V just below your ears (one strap in front, one behind) and you may need to adjust the straps to ensure this.

The helmet should sit comfortably but should not slip forward with head movement (nod your head to check this).

motion on the bike will be easier to use. Choose a knee that is safe to walk on in a free swing mode or that can be easily switched from one mode to another. For mountain biking, there is a specialist knee, the Bartlett Tendon; this unique system enables the amputated leg to provide power back to the bike, as well as enabling the user to stand and sprint out of the saddle.

Upper Limb Amputees

If you are an upper limb amputee, you can choose to cycle with or without a prosthesis on. Upper limb amputees tend to use their prosthesis for gripping the handle bar to steer and to operate the gears and breaks. Front and rear brakes can be mounted onto the bike in the same location on the side of the sound limb so that an upper limb amputee can operate these functions. However, this will affect your balance, especially if you wear your prosthesis for all other activities. If you choose to wear your prosthesis, any with a hand that is fitted with a voluntary opening and closing mechanism should be sufficient. A cycling prosthesis needs to be used in different positions during the ride, should be light and bespoke for each cycling discipline. For above elbow amputees, an elbow unit can be attached to the prosthetic device, which can be locked at different angles or left unlocked. Some

people prefer to have a bespoke device that remains attached to the bike until use featuring a release mechanism in case of impacts.

Step Four – Your Bike

Ensure your bike is the right frame size and has a comfortable 'reach' to the handlebars. The distance between your crotch and the top tube (cross bar) determines the frame size of your bike. The right sized frame should have at least 6cm clearance. Consult a cycle shop for advice.

Bike Adjustments

Make sure your saddle is at the correct height. With the balls of your feet/ foot on the pedal/s, your knee should be very slightly bent at the bottom of the pedal stroke. Above knee amputees will find that having a good saddle height will increase the clearance of the socket and reduce discomfort. Do not increase the height too much as this can put a strain on your sound (non-prosthetic) knee and hip. You may also start to rock from side-to-side as you pedal which causes back issues. There is a trade-off between being able to stop and put your feet on the floor for balance and the efficiency of having a higher saddle and as you gain more experience (and balance) you may be more comfortable raising the seat. Cycling requires a smooth cadence but

“Cycling is easier than walking for me and gives me a sense of freedom that I don't feel with any other activity.”

amputees often find there is not enough clearance between the foot and the knee when pedalling to allow this. Having a shorter crank on the side of the artificial limb can overcome this.

You will also find it important to secure the artificial foot to the pedal for safety. Options are:

1. Toe-clips with straps, which you can buy from most bike shops.
2. Clipless pedals (cleats), which have mechanisms that clip your cycling-specific shoe directly onto the pedal.

Cleats will lock your foot in place and can be difficult to release and can take some getting used to, but once mastered they are an excellent way of keeping the foot on the pedal. Mountain bike cleats are not as stiff as road bike cleats, so it is easier to detach the foot. If the cleats are too stiff, ask the mechanic at your local bike shop to loosen them. This can be done by filing the cleat. The other advantage of mountain bike cleats is that the cleat is recessed in the shoe making them easier to walk on.

Step Five – Get going

Before you get started do a basic bike check such as this:

Basic Bike check

Here are the main basic checks you can make on your bike before you go out for a ride.

Although you can make minor adjustments, we recommend you use a qualified mechanic at a bike shop for more complicated adjustments.



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- ➔ **1 Tyres** should be pumped up hard. They must have adequate tread and no splits or bulges.
- 2 Saddle**
Make sure the saddle is the correct height. A rough guide is to be able to touch the floor with your foot when you're sitting on the saddle.
- 3 Brakes**
Your Brakes must work effectively. The rubber blocks shouldn't be worn and must hit the rims square on.
- 4 Levers**
Make sure your fingers can reach the brake levers comfortably.
- 5 Wheels**
Lift the bike and spin the wheels to check the wheels are true and not wonky.
- 6 Handlebars**
The handlebars should turn smoothly and be in line with the front wheel and not be loose.
- 7 Gears**
The gears should change easily into all gears. The chain should be lightly oiled.
- 8 Pedals**
The pedals should spin freely. Check the cranks (the arms holding the pedals) don't wobble from side-to-side.

Go to a safe place away from traffic and pedestrians to practice, such as a British Cycling Hub. If you don't have a cycling hub in your local area, take someone with you as you may need their help with pushing off and stopping to begin with. Look for somewhere flat with gentle slopes. Grass will give you a soft landing and will be a greater test of balance and resistance on

the pedals. The flatter and more visible the terrain, the easier it will be to maintain balance and momentum, so stay away from undulating tarmac or cracked pavements. Mud and wet leaf patches or broken glass and stones will not only push you off balance but can also damage your tyres.

Safety

Wear a helmet and knee, wrist and elbows pads.

If you don't have a companion, use a wall or fence to lean against when you first push off. This will support you while you find your balance. Be prepared to fall off!

Basic skills you need to master before you take your bike on the road (or off-road in the case of mountain bikes) are; getting on (mounting) your bike, balance, pedalling, breaking, changing gear, steering, stopping (the most important one!), looking around including behind, without loss of control, signalling right and left, getting off (dismounting).

Modesty

When cycling, it is likely that your residual limb will sweat, shrink or move around in the socket. It is likely that you will need to take your leg off and clean or adjust your prosthetic in public, including adding or removing stump socks. If you do feel uncomfortable doing this in public, consider training in a park with a public toilet or somewhere you can take your socket off in relative isolation.

It is normal with any new activity to experience frustration, you will improve with time and repetitive practice. We all develop our own way of coping, especially children who may need space to learn to enjoy the experience of cycling.

Step Six – On the bike

For building up fitness and putting the miles in, comfort is of paramount importance. What is comfortable for a short and gentle ride may not be comfortable for more intense training.

Prosthetic Maintenance and Checks

- 1** On a weekly basis check your prosthesis for defects, scratches, loose screws or weak rivets.
- 2** Keep your prosthetic limb free of dirt, sand and other debris.
- 3** Unless stated by the manufacturer, do not get your prosthesis wet.
- 4** Check your socket fit (adjust sock use if necessary). Adults will need a new socket every 2/3 years once their injuries have consolidated. Children need a new socket every 6/12 months.
- 5** Check your knee joint does not make unusual noises (commonly clicking).
- 6** Check the age of your prosthetic, most manufacturers offer a warranty between 1 to 5 years (check yours). If you continue to use your limb past the warranty, be aware of the risks of mechanical failure.

If your walking pattern changes or your socket feels tight/loose, speak with your prosthetist.

Here are some techniques to help you.

Rule of thirds

Distribute your body weight evenly between your hands, feet and your seat. You'll probably find yourself leaning forwards at an angle of 30 to 45 degrees – halfway between an upright position and a low, crouching position. With your weight evenly distributed, you are less likely to feel pressure on your back or stomach.

Cadence

Cadence (pedal rate) is the rate at which the cyclist turns the crank. You should be looking at 85-100 rpm for a smooth and efficient pace. Over-gearing is unnecessary and wastes energy. As you don't have as much strength in your residual limb, hill climbing is more difficult. You can combat this with training and tackling the hills in a lower gear and a higher cadence. Make sure your bike has lots of gears.

Types of cycles

Why do you want to cycle?

For pleasure, to get fit, to commute, to join a club, competitively or do you have your sights set on the Paralympics? Do you want to cycle on the road, off-road or on the track? If you are not sure, why not attend one of LimbPower's cycling clinics or a British Cycling Hub Session where you can try different bikes and get useful advice.

There are many different forms of cycling that may be suitable for an amputee or individual with limb difference. Road bikes, hybrid (half road-half mountain bike), touring bikes, mountain bikes, folding bikes, utility bikes, BMC and Cyclocross bikes, track bikes, time trial bikes, tandems and electric bikes.



Bike Fit

It's about getting the right balance between comfort and technique. The position of the handlebars, saddle and pedals will affect your comfort, stability and ability to generate speed. Go to a bike shop and have your measurements taken before investing in a new bike. Your body measurements will be compared to the bike's measurements including; crank centre to saddle, distance from the handlebar to the saddle, angle of seat tube and the width and lengths of the components. Your knees need to have a slight bend (about 30 degrees) when your feet are on the pedals at full reach and there should be a good 3-4" clearance between the top tube and your body. Bike fit measurements are created for

non-disabled cyclists, so you will need to make further adjustments based on trial and error. If the socket is becoming impinged, try raising the bicycle seat or making adjustments to reduce the required amount of knee and hip flexion. Ensure the adjustments made enable both legs to be involved (unless cycling without your prosthetic leg on). If you need help, ask your prosthetist to observe you pedalling on the bike.

Prosthetic adaptations and assistive aids

New designs in socket, feet, knees and suspension systems are giving today's amputees greater freedom and more choice. Ask your prosthetist to find out the best set up for you and your cycling needs.

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Bikes and adaptations

Pedals

To correctly place and keep your foot on the pedal you will need to use straps, toe clips or cleats (road bike spd or mountain bike mtb). The option of cleats, toe clips or specialised bicycle shoes allow force to be transferred efficiently from the legs to the pedals, both from the sound limb and the prosthetic limb.

Securing the foot

You can use toe cleats or clips if you can pedal with the ball of the foot. If you are unable to pedal with the toes, or just prefer powering through the heel, position this part of the foot in the middle of the pedal. This can allow more power through the foot due to the rigid nature of the heel, as well as the possibility of direct force from the residual limb. This has the added benefit of supplying more proprioceptive feedback to the rider. In these cases, the foot may be held in position using more basic straps. For bilateral amputees, the foot must also be fixed in place, but it is important that this is done using a method which can be released quickly, with some amputees opting to cycle with only one foot attached. Toe clips or cleats are therefore generally avoided as this may compromise safety.

Toe clips

Great for amputees who are new to cycling, as they secure your foot to the pedal, but you can still release your foot quickly should you need to.

Cleats

Cleats are more difficult to use and you may fall off while you get used to them, but they have many advantages and there are

a wide range of cleats on the market. Mountain bike cleats are easier to clip out of than road spd clips. They are also easier to walk on as they are recessed into the shoe. Multifunctional pedals can be useful once you are used to them and found the right clip in position, they can be used with or without fixing. A good bike fitter should be able to aid you with the cleat set up, but it is worth practicing the clipping in and out motion either on a trainer in the bike shop or propped up against a wall before setting off.

Pedal Extension

If the heel of the prosthetic foot is catching the crank or chain, a pedal extension may be needed to add an additional 2.5-3 cm between the pedal and the crank. This can also be used if either foot is creeping into a toe out position during cycling.

Saddle

A comfortable saddle is crucial for both short distances and long distances. For above knee amputees, a narrow road bike saddle is the best option to minimise contact with the socket, thereby reducing friction. The issues of knee flexion limitation and socket irritation for lower limb amputees may be mitigated by raising the saddle or changing the pedalling motion (using mid-foot or heel on the pedal). Either of these options reduce the amount of knee flexion required to pedal but may require the foot being strapped into position.

Crank

The crank length affects pedal movement. The larger the diameter of the movement, as with larger cranks, the more flexion experienced in the knee. The crank length should be sufficient to enable the cyclist to

get past the 90-degree bend in the knee at the top of the pedal stroke. Amputees should choose a shorter crank on the prosthetic side, which requires less knee flexion. You can alter the crank length or change the crank system being used or increase the seat height to compensate for the prosthetic limitations. The optimum crank length for cardiac efficiency is 120 millimetres to 160 millimetres.

Q-rings

There are two points in every pedal stroke when the moving crank can falter, this is at the top of the stroke and at the bottom of the stroke. At the top of the stroke, the foot and leg must change from moving back and up to forward and down. Riders who are not as strong or efficient at these two points can waste a lot of energy. Using a Q-ring allows a smoother transition at these two points. The Q-Ring is an oval-shaped chain ring, rather than a round shaped chain ring. How is it different? With a Q-Ring, the smallest radius position is at the top and bottom of the stroke, which means your foot can transition more easily. The greatest radius position is at 3 o'clock giving you more leverage and power.

Cycling one legged

To provide additional support for lower limb amputees cycling without their prosthetic, especially in standing cycling positions, a cuff or sleeve can be used. It should be attached to the cross bar (top tube) of the bike, in such a way as allows the residual limb to be held in a comfortable position. It is especially important to pay attention to the condition of the residual limb and release it from the cuff or sleeve if swelling occurs.



“ Learning to ride again as an adult amputee seemed daunting at first, but with only a few very minor tweaks you realise how easy it is. Cycling taught me there wouldn't be anything I couldn't overcome. ”

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Gears

There are different types of gears; single, fixed, multiple gears, electronic gears etc. The more varied the terrain, the more gears you will need. Gears are there to help maintain a smooth pedal speed, no matter the changes in terrain or elevation. Smooth comfortable cycling is generally between 80-90 RPM (this cadence has been scientifically shown to have the lowest EMG, regular muscle activity compared to other pedal speeds. In lower gears, the rider has to compensate by pedalling faster as each revolution creates less force, in higher gears the cyclist can pedal slower but with more force. The number of gears can range from none (fixed gear bicycle) to



33 gears. Bikes can have gears on just the rear wheel or on both wheels, this allows a variable combination of settings, resulting in the maximum number of gears possible.

Gears for upper limb amputees –

Mount both the gear shifters on the handlebar of the sound limb.

Brakes for upper limb amputees

There are 3 main types of brake system used today.

Rim – acting on the rim of the wheel (held in the frame of the bike)

Disc (similar to rim breaks these are often cheaper to replace and put the pressure on at the centre of the wheel).

Drum (like car brakes these push out against the breaking surface in the centre of the wheel, rather than pinching in as other brakes do).

Handle bars – should be an inch or two above the saddle. You should be able to reach them comfortably with elbows slightly bent, with your back leaning forward at a 45-degree angle. Racing handlebars are positioned 10 to 20 degrees lower (dropped). Upper limb amputees may find dropped handlebars more difficult. You can mount both the front and rear brake levers on the handlebar on the side of the sound limb. It is possible to get a brake system where the front and rear brake cables are together and can be used at the same time. The handle bar on the residual limb side can be removed for amputees who cycle without a prosthesis on or for individuals with limb difference.

Cycle Training

The amount of cycling you can do to begin with will depend on your physical strength



and cardio vascular ability. You will need to train by starting slowly with a low level of resistance, building up gradually by increasing your ride length and/or resistance. There is a general rule of 5% build up in overall distance covered from one week to the next to avoid injury. This gradual increase will minimise the risk of friction, sweating, swelling and blisters on the residual limb and on the residual foot. Increasing your distance gradually is also an excellent opportunity to keep a record of and monitor any issues with the prosthesis and with your residual limb. Through trial and error, you can make the necessary adaptation to combat any issues which arise. For this reason, LimbPower recommend starting on a static (stationary) bike, this offers maximum control of the environment and without ending up miles from home if you get into trouble. Lots of gyms and health clubs offer trial memberships for you to have a go on the static bike or you can invest in one to use at home (there are a variety of types for a range of prices). If you are using a shared bike (such as in a gym) make a note of your personal settings (e.g. seat height).



Residual limb care and injury

Amputee cycling is a non-weight bearing activity; however, skin problems can occur on the residual limb (amputated side), either due to interactions with the socket (trim line friction, pistoning etc.) or from sweating. Please read Practical Tips for Sport and High Activity factsheet. You can find this on the LimbPower website www.limbpower.com/index.php/resources/info-sheets

Injury prevention

Amputees should complete their daily exercises provided by the limb centre on discharge to keep the residual limb

(amputated side) mobile, to reduce the risk of contracture and to maintain the muscle size and attachment. It is also wise to regularly exercise focusing on agility, balance and co-ordination exercises and strength and conditioning exercises, such as those on the LimbPower website <http://limbpower.com/index.php/resources/toolkit-videos> or the Ottobock Fitness Application or through attending yoga or pilates classes. These will all help with posture imbalance which can cause back pain and spine related issues.

Contracture is caused by the shortening of the connective tissues in the residual limb (amputated side). This can be avoided through daily exercises.

Back pain is caused by the asymmetry between the sound limb and the prosthetic. It can be caused by a height difference in the limbs, the weight of the prosthesis, altered gait or an ill-fitting prosthesis.

Other biomechanical injuries can occur from repetitive strain or bad movement patterns, it is important to get a balance between load tolerance (how much strain a given body part can take) and correct movements. When starting a new exercise or sport it is good to have someone assess your abilities or movements and to guide you with supportive exercises.

Residual limb care – check list

When embarking on exercises, it is vital that you take care of your residual limb as any injury can impact on your daily mobility. When looking at residual limb injury prevention we can break the check list down into two categories; skin hygiene and skin inspection and maintenance.

Skin hygiene

- Wash the residual limb with soap and water every morning and every night, dry well before putting on your prosthesis.
- Rub moisturiser onto the residual limb, avoiding any open wounds.
- Clean the sleeve/liner with soap or anti-bacterial wipes. Do not use on the skin directly.

Skin inspection and maintenance

Check your residual limb every morning, every night and most importantly after every exercise session. You are looking for any form of irritation or tenderness, blisters, cuts, dry patches or red areas, ingrown hairs and hives, swelling and bruising, shrinking, pressure sores and skin breakdown, particularly along the scar line, which is prone to skin breakdown and blisters. In the resources section of the LimbPower website you can read about preventative measures and treatments for these common residual limb related injuries in our Practical Tips for Sport and High Activity factsheet www.limbpower.com/index.php/resources/info-sheets

Further reading

- *Stumps and Cranks* by Sonia Sanghani
- *The Cyclist's Training Bible* by Joe Friel
- *Anatomy, Stretching & Training for Cyclists* by Lisa Purcell
- *Cycling Training for Beginners* by Hector Abazis



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LimbPower exists to engage amputees and individuals with limb impairments in regular and sustained participation in physical activity, sport and the arts to improve quality of life and to aid physical, social and psychological rehabilitation. To find out more about how we can help you, visit our website. LimbPower is a Limited Company No. 09513024 Charity No 1132829