

## The importance of prosthetic devices in sport activities for Romanian amputees who compete in Paralympic competitions

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**Abstract.** The aim of this study is to provide information about Paralympians and the importance of their prosthetic devices. Many people today are encouraged to take part in some kind of sport activity, because many studies have shown that these activities have a positive influence on several aspects of one's life; improving physical health and also self-esteem, but also helps to reduce stress levels, improving concentration and problem-solving skills. A special category of people who are practicing some kind of sport activities are people who have suffered a limb loss or so-called amputation. Most of them having been very active people and practicing sport even before the amputation, have returned to their activities and are still competing in para sport activities. The methods used are interviewing the candidates and as materials we have written a series of questions that were sent to each of them. Working in the field of prosthetics and having the chance to work with such motivated people, we have tried to conclude the importance of using a prosthetic device in such activities.

**Key words:** prosthetic, disability, sport activity, amputation, Paralympic

Competing is in our human nature. Every human being is alive because he has won his first competition in his life at the stage of conception. For some of us, especially males, competition has been important for the survival of our genes. People of today can experience their need for competition by practicing different kinds of sport activities and those who are really competitive will take this to a whole new level by practicing competition sports. In order to practice a sport activity, a person needs to be persistent and self-motivated, especially because sport is very challenging. But it also has a lot of positive effects on one's physical, mental and social life (1-3). Practicing sports from an early age is beneficial from many points of view; children involved in sport activities will develop better motor skills, they will have better results in activities which need balance and endurance, their capacity of concentration and focusing will be improved, they will also have a better self-esteem and will be able to cooperate with others. All the advantages of practicing sport and motor activities will have an influence on the later development of a young adult and even more at the future adult and elderly people.

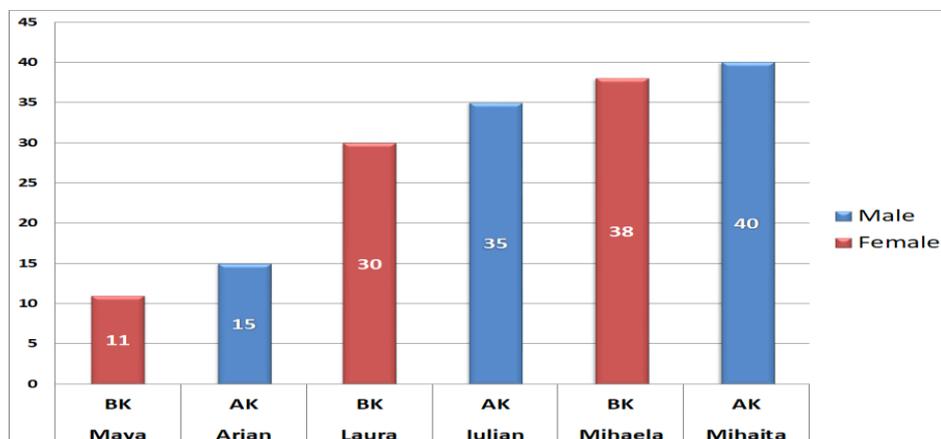


Figure 1. Age of subjects

In this article we have focused on the history and performances of six persons who have suffered a limb loss due to different causes (motor vehicle accident, train accident, wild animal attack, medical conditions) and all of them had been practicing some kind of sport activity before the amputation. Some of them were doing sport at a very high level participating in national competitions obtaining very good results as national champions, others only practiced sport as a hobby. But all of them had a history in such activities. Their positive attitude regarding their new life situation, has very much been influenced by the fact that they all have been practicing sport and motor activity before their limb loss, thus making them much more confident and helping them to adapt to this new condition which they have found themselves in.

Practicing sport activities in their past, both their physical and mental conditions were at a much higher level. As persons who are involved in sports, they have developed good muscle tonus, mobility and endurance. They also had the potential for a much faster healing process with the mental strength to plan their future actions regarding recovery and stepping forward.

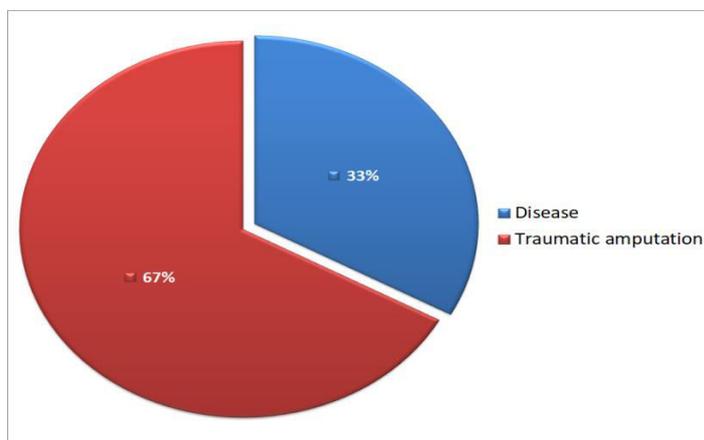


Figure 2. Amputation causes

Out of the six people we have included in this study case, three are male and three are female aged between 11 and 40 years of age, three of them have suffered trans femoral amputations and three of them trans tibial amputations. Trans femoral amputation requires the use of a prosthetic knee in the manufacturing of the prosthetic device next to the prosthetic foot. Functions of the prosthetic knee will have a big impact on the level of the activity of the user, and in some cases will affect the outcome of the sport activity in which the user is competing. Three of the users are competing in winter sport events, two in parasnowboarding and one in paraskiing, two of them in paracanoeing 200m kl3 and one person is participating in para swimming with his favourite event being 100m backstroke.

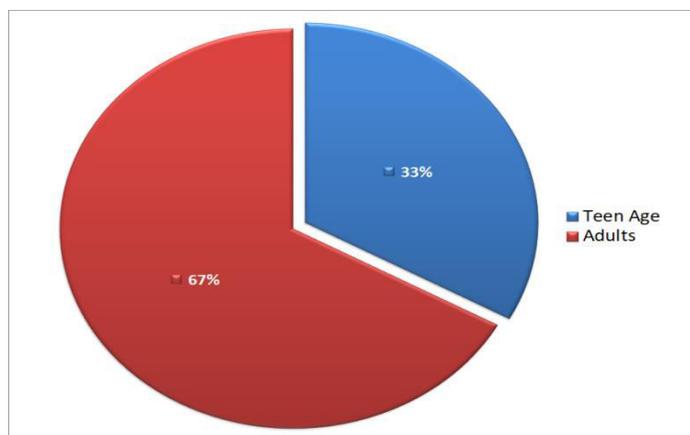


Figure 3. Distribution by age groups

The para swimming event is the only one that will not require the use of the prosthetic device during the competition or the sport event, although the use of the prosthetic device is needed to get to the swimming pool and after the race back to the lockers room, but it will not have a direct effect over the outcome of the competition. In the other sporting events like the para canoeing, the use of a prosthetic device can be a choice of their user. Our participants are competing without it so they have adapted their sport device (canoe) to fit their missing limb. On the other hand, the participants in winter sport events, para snowboarding and para skiing, are the ones that will depend totally on their prosthetic device and therefore the fit and the parameters of these devices have a very high factor in the efficiency of the sport result. As one of the users explains: "In professional sports the equipment must be always somehow individual and a perfect fit is crucial. As a sportsman you must feel complete with your equipment, as in everyday life your clothes and shoes should not bother you and feel like air, so it is in sports. The equipment should fit so well so that you can completely concentrate on your performance. It should feel as if you are naked and there is nothing that can bother you". The outcome of the prosthetic device depends on many factors but the main objective is to have a perfect fit because as the previous user explains: "For disabled people with amputations the prosthetic leg is part of the sport equipment and it should fit so well, that it gives you the impression that is your real leg".

One of the other users explains: "The prosthetic is crucial, but it works hand in hand with the physical and technical training. No matter how good the prosthetic is, it needs to be controlled by someone with certain skills, force and mobility. It cannot substitute all the functions of the real limb, not yet anyway". All the users have reported to have training sessions five days a week between two and four hours each day, sometimes twice a day, in which they will have work on physical training but also on endurance and mobility. We all know that in many competitions the sporting event itself can last between a few seconds to a few hours depending on the discipline. For our candidates this varies between a few minutes in ski, snowboarding and canoeing and even a shorter period in the swimming competition. As mentioned above, the swimming competition is the only one that does not require the use of a prosthetic device. All the other Paralympians depend more or less on their prosthetic device.

Herewith we wanted to point out that even if the prosthetic device is used for a short or very short time during the actual race or sport event, their use is crucial for the period of training and preparing for the sport competition (4) Not only are these Paralympians having a busy schedule with their training sessions, but they are also using the prosthetic device in everyday life. In some cases, the competition prosthetic device can be a different one from the one they are using in the real life for daily activities. These kinds of prosthetic devices are made in order to make them much lighter, in some cases a few kilograms can make a big difference. On the other hand, some of the prosthetic components like knees or prosthetic feet are specially designed and used only in competition. For example, our para snowboarder is using a very hi-tech knee unit design especially for very active and high impact demanding sport activities. It also allows him to load the prosthetic foot and also to make jumps and other tricks on the slopes. Cost of these prosthetic devices as well as the provenance of the financial resources for Romanian athletes are important factors, but do not represent the focus of this study.

The other Paralympian who competes in Super G and Downhill events is a transtibial amputee which means that she has her natural knee joint and the prosthetic device is just replacing the lower part of her foot, below the knee, and as she posted: "There should be no movement in the socket, no leakage, no pressure points, no open wounds on the stump, every single edge and orientation should be immaculate and so individual as possible." This is very important because the prosthetic device will assure the Paralympian that he can focus 100% on the sport event and the race and should not be afraid to lose her ski or prosthesis. She also stated that: "my purpose has always been a one to one transmission from the ground to my stump - the most accurate proprioception - so that I can feel every single bump in the slope". As you can see, although a significant part of the prosthesis is inside the ski boot and somehow in a fixed position, the importance of a good fit in a good socket is crucial for her performance. The manufacturing of the prosthetic socket is a key factor in the final successful outcome for the amputee.

Another participant in the study, the 15-year-old Paralympian, is competing in swimming. As mentioned earlier, this is the only discipline where competitors are not using the prosthetic device, but it still has a huge importance in the training sessions. More than that, our young athlete is planning to participate and compete in the triathlon, which means he will have not only to swim but also to run and ride a bicycle. For these purposes he will have to have a specialized prosthetic device that can be used in a long-distance running event and also to be easy to don and doff. This prosthesis will include not only an energy restoring running

prosthetic foot, but also a knee unit capable of ensuring a sustained impacting physical effort such as running.

As for the Paralympians competing in para canoeing, they have chosen to compete in their discipline without using a prosthetic device but in order to achieve this they had to develop motor skills and improve their balance to be able to sit in their canoes with a high level of confidence. In this case the person is using his upper body's strength most of the time in order to paddle. Their main activity which will involve the use of a prosthetic device will be at the gym where they work on strengthening their muscles and gain endurance and force.

We addressed the following questions to the 6 amputees, all of whom have given their agreement that their stories and personal details can be published in this magazine (*Medicina Sportiva, Romanian Sport Medicine Journal*).

1. Did you perform/compete in sport activities before and/or after your amputation?
2. What was the cause of your amputation?
3. Which were the most important challenges that you faced after the amputation?
4. How much time did you need to fully recover? (physically, psychologically and emotionally)
5. In which sport do you compete and which is your favourite event?
6. How much time do you allocate for training during the season of competition as well as off-season?
7. In your opinion, how important do you consider prosthetic equipment to be when factoring in your notable competition achievements?
8. Could you give words of encouragement or suggestions for other individuals with amputations who consider embracing a lifestyle of sport?

- **Case 1-** woman, 30 years old, physician specializing in Physical Medicine and Rehabilitation, alpine skier before amputation.

*“My passion and satisfaction are adrenalin related sports. From a very early age I was interested in sport, taking up Alpine Skiing at the age of 5. By 2004 I was competing in the Romanian National Championships and was regularly winning medals at all national competitions. During the winter of 2005 I became national champion in Giant Slalom.*

*On the 11th September 2006, while driving my motorcycle I was hit laterally by a car and subsequently my right leg was amputated below the knee. After the accident my father's best friend brought me a gift - a DVD of the Winter Paralympic Games in Torino, Italy 2006. It was the first time that I had ever seen people with certain disabilities skiing and in fact competing at the highest level possible. Some people felt pity for me and did not know how to react. But many encouraged me by telling me that even with this disability everything is possible and that I could return to skiing. So that December, not even 3 months after my amputation, I tried to ski again on the same slopes where I began skiing when I was 5 years old. I remember that moment vividly, it felt strange but I was happy to be back on the slope. I tried hard to do everything perfect, although I knew it was going to be a long, long road back to full form.*

*I actually needed about 1 year to get comfortable with my prosthetic leg and about 2 years to define my prosthetic as part of me. At the beginning I simply tried to walk with crutches for one week, then for another week with a walking stick and afterwards for some weeks holding the hand of someone from my family or my friends.*

*On skis it took one day of practice to get the confidence and ski completely on my own on a long slope in the Carpathian Mountains. To get to the racing level I have been before took me 7 years, up to then experimenting different prosthetic legs, different orthopedic technicians, different coaches and various ski equipment (boots and skis).*

*At the beginning, right after the hospitalization time I had some sessions with a good friend of my mother's, who is a Psychologist and in a couple of days she helped me overcome my phantom pain. Emotionally I was very stable because my greatest wish was to ski again and as I mentioned earlier, I had the opportunity to do that less than 3 months after my accident and that gave me the strength and the confidence I needed. Of course, I had my family and so many friends who supported me.*

*First, I started with the technical events - Slalom and Giant Slalom and later on I tried the speed events - Super G and Downhill. Soon I started being constantly on the podium in Super G, my favorite discipline.*

*The full season starts in October and ends by the end of May, during this time I train on skis every weekend and every single free work day, the rest I compete. In summer I do physical training every day including mountain biking, inline skating, swimming and water skiing. To compete and train in all disciplines and engage in a full-time job is simply impossible. So, in 2016 when I finished my studies and started my full-time job, I decided to focus just on the speed events.*

*In professional sports the equipment must be always individualized and a perfect fit is crucial. As a sportsperson you must feel complete with your equipment, as in everyday life your clothes and shoes should not bother you and feel like air, it is similar in sports. The equipment should fit so well so that you can focus totally on your performance. It should feel as if you are naked and there is nothing that can bother you. It is the same for the helmet, for the suit, for the ski boots etc. For disabled people with amputations the prosthetic leg is part of the sport equipment and it should fit so well, that it gives you the impression that it is your real leg. I have always loved vacuum sockets, only with vacuum I feel there is no gap between my stump and my prosthetic. There should be no movement in the socket, no leakage, no pressure points, no open wounds on the stump, every single edge and orientation should be immaculate and so individual as possible. Experience is one of the most important things in life - experience with yourself and your environment. So that you know exactly what you need and where you can get it to achieve that certain performance. It is about an enormous cooperation with your environment - specifically your orthopedic technician, your trainer etc. It is always about good teamwork and you as an athlete have to think accordingly. I remember going skiing with one of my ski technicians and telling him what I would like to have changed after every run, experiencing so much during the practice. I used to spend the weekends in summer to work together with my orthopedic technician to improve my prosthetic leg or to create a newer better one.*

*It's a matter of practice, courage and of course confidence - feeling confident with your prosthetic leg, as if it were part of you, and on the other hand a matter of time and patience and a matter of having professional people around you who can help and advise you.*

*My purpose has always been a one to one transmission from the ground to my stump - the most accurate proprioception - so that I can feel every single bump in the slope, every little condition under my skis and on their fine polished edges. And I managed to achieve that. Believe me, this is possible, because you and everything in you is possible.*

*It is about a lot of work and devotion trying to reach that level where everything regarding equipment and the prosthesis is just perfect, so that your attention is targeting the highest performance, so that you can focus only on the way you act and react, without blaming other things that need to be fixed!*

*I think it is really important to have targets in life and to achieve your goals and that's what a Paralympic athlete does! That is what makes your life full of ups and downs but complete, and that's what makes you stronger. Sports will always give you a constantly new mixture of emotions, a unique satisfaction. For any other Romanian who wants to become a Paralympic sportsman/woman: take courage, determination and ambition to step out, embrace the struggle and become an elite athlete”.*

- **Case 2** - male subject, aged 40 years, ski, swim and climb practitioner before the amputation.

*“I practiced sports before my amputation, but not at competition level. I was living an active life and loved to ski, swim and climb. Exactly one week before the car accident that left me disabled, I had had my first solo paraglider flight. I had been preparing for many months to obtain my paraglider pilot license (my amputation stopped that dream, even though I have since flown with a paraglider, in tandem, with a certified paraglider pilot). After the amputation, for several years I struggled to start practicing regular sport activities. Since 2014, I practice mainly adaptive snowboarding.*

*I was involved in a car accident (I was driving). The amputation was immediate, due to trauma caused by the road protection metal barrier piercing my vehicle.*

*The most overwhelming challenges at that time were due to the lack of education in the area of disability.*

*For many years, I had a very difficult time finding information on how to recover and how to deal with my new medical (physical and psychological) situation.*

*I started practicing adaptive snowboarding (parasnoboard) in 2014, and I represent Romania in international competitions' love the Snowboard Cross and the Banked Slalom.*

*This season, 2019-2020, World Parasnowboard added a brand-new competition on the list, the Double Banked Slalom, and this format is even more fun, especially for me having the opportunity to gain a place the podium.*

*Snowboard training is done only partly on snow (for specific technical exercises), the majority of it being done in the gym (for force, endurance and mobility). Therefore, training is all year round, between 10 to 20 hours every week. The competition season usually starts in November and ends in April. During these months, we spend more than 10 weeks on snow.*

*The prosthetic is crucial, but it works hand in hand with the physical and technical training. No matter how good the prosthetic is, it needs to be controlled by someone with certain skills, force and mobility. It cannot substitute all the functions of the real limb, not yet anyway. To start right away, without hesitation. Sports help with physical, emotional and even social recovery. There are so many benefits from sport activity, that it should be used widely and extensively as a recovery method for people with disabilities.”*

- **Case 3** –woman, 35 years old, kayaker and canoeist before amputation.

*“I’ve been doing kayaking since I was 11 years old. I had my amputation in 2007 whereupon I continued practicing kayaking, the discipline adapted for people with disabilities (paracanoe kl3 200m M).*

*In 2007 I tried to catch the train from Busteni to Bucharest which was already in motion. I slid off the stairs and fell under the train. After the train passed I realized that it severed my leg. I noticed my leg on the other side of the rail. I called for help and fainted. I woke up in Bucharest at the hospital where I spent the next 6 months. After 6 months, my biggest challenge was to learn to walk again. First in a walking frame and then crutches. After 18 months of recovery I received a prosthesis for my right leg. I restarted kayak training for the adapted paracanoe events. On the mental side I was doing well. I didn’t have too much trouble, because I was able to get back in the activity quickly. Coaches and colleagues gave me the encouragement and strength to continue and integrate very well.*

*Kayak - canoe which I have practiced for 21 years is my favorite sport and the discipline that I prefer most is kl3 200m Man, being the discipline which I won for years in a row, 4 times world champion and 5 times European champion. In a competitive year I spend 8 months in training camp, training twice a day. A workout lasts between 2-3 hours, only Sunday was free.*

*Having a good prosthesis is crucial for the correct exercise and walking. Without a prosthesis and therefore being forced to walk with crutches, I would have tired my arms and I couldn’t face the training on the water, where I used my arms a lot.*

*Usually it takes a long time to reach high performance, so a lot of patience and ambition is required to be able to achieve remarkable performances. If somebody has a dream, never give up, because with work and motivation, it will be fulfilled.”*

- **Case 4** - woman, 38 years old, handball player and judo practitioner before the amputation.

*“In 1993 I was attacked by a bear at the Zoo in Timisoara. While sitting on the protective fence for a moment, I lost my balance. The bear grabbed my leg and tore it and broke my femur.*

*At that age of 11, I gave up school since I could not reintegrate into the school system. I had to spend my time with something. Therefore my biggest challenge, especially after acquiring the disability, was to continue practicing sports and do well and get good results. The recovery has been long and I can say that, only at the age of 30 did I manage to really get over it, after I realized that all things happened with a purpose.*

*I did sports before my amputation. I played handball in high school and during the period before the accident, I practiced judo. After the accident, my first contact with sports was canoe kayaking, which I practiced for 2 years. I gave up kayaking and started playing table tennis.*

*My favorite sport remains the kayak (Paracanoe) 200m-kl3 and I use to spend around 5 hours of training per day divided into 2 workouts usually 5-6 days a week, 8 months a year.*

*The prosthetic equipment is very important for me. If you do not have a good prosthesis that is comfortable and makes you feel like one body, it is very difficult. A small example would be, to do pull-ups and your prosthesis falls off your leg. My recommendation for an amputee is to attempt several diversified sports in order to have a choice. Then to excel in the one chosen. They need a lot of ambition and determination, even if it means sleepless nights and muscle pain. Many will say that they do not have time for anything else and so on. Patience; a high level of performance is not obtained within a year or two.”*

- **Case 5** - male adolescent, 15 years old, rugby, football, karate practitioner before the amputation.

*"4 years ago I suffered an injury during a rugby match, which was followed by surgery, which subsequently had complications, amputation apparently being the only solution for doctors and for me to survive. After the amputation, the hardest challenge was physical recovery because the muscles were atrophied and I was immobilized in bed for about 3-4 months.*

*The sport I practice is swimming, and my favorite discipline where I perform with good results is 100 meters backstroke. The time allocated for training both in the competitive and extra-competitive period is approximately 4 hours a day, 5 days a week with the mention that the intensity of the effort is different from case to case.*

*In order to perform in this field, a good physical training on land (gym, running, cycling) is necessary. In this case the prosthetic equipment has a very important role. Confidence, ambition and perseverance are three essential things in practicing a sport of any kind. I believe that amputation, regardless of its nature, is a challenge, but not an obstacle for life. The quote I use to guide myself and guide others to do is: "Your body can do anything. You just have to convince your brain".*

- **Case 6** - girl, 11 years old, cycling, rollerblading, swimming practitioner.

*"I am on a 5<sup>th</sup> grade student at the Theoretical High School "Alexandru Ioan Cuza" and I am passionate about sports and foreign languages. Before amputation, the sports I practiced were outdoors together with my friends, such as cycling or rollerblading and swimming, which I still practice today. After the amputation, I continued with these sports and started an activity that I had not practiced, snowboarding, which I fell in love with.*

*In the fall of 2016 I was diagnosed with osteosarcoma (bone cancer) and after 6 sessions of chemotherapy, doctors said that to save my life, the best solution, is to amputate 1/3 lower, below the knee, left limb. The news I received was difficultly accepted by my whole family, but being the best solution to continue enjoying life, I learned to live with the idea of having a disability.*

*The post-amputation period was difficult in the first 5 days, when I was confronted with the sensation of a "phantom foot", which I could only overcome with the help of specialists. I also refused to depend on the wheelchair and I wanted to be able to handle the crutches until the prosthesis. The whole adaptation lasted about 5 months, until I got to the Prosthetic Center, to people who showed me that even with a disability I can do amazing things.*

*Currently, I want to evolve in this new sport that I discovered, snowboarding, which gave me the opportunity to practice and learn about it in different countries, giving me the opportunity to meet new people who are different and unique, but at the same time like me. I want to participate in snowboard competitions in the future, but to be able to do this it takes training and ambition. Also, the prosthetic equipment is the most important factor because it helps me to coordinate on the board, to maintain balance, it gives me comfort and safety in practicing sports to achieve a remarkable level of performance.*

*I would like all people with amputation not to give up on their dreams, to continue to do what they want and love and to remember that there are no limits even if you have an amputation. A sport can help you, teach that you can push your limits and that you can do extraordinary things that you would not have suspected you could do. I discovered that through a sports activity you will find out that there is life after amputation, being able to look forward to great things.*

## **Discussion and Conclusion**

We discovered that through a sports activity you will find out that there is life after amputation, being able to look forward to great things. Since 1988, there has been a marked improvement in the technology, particularly in western nations, associated with leg prosthetics. The materials from which prostheses are made have changed markedly from wood to fiberglass to all manner of carbon fiber and lightweight metals used in advanced scientific design (5). These mobility aids have been a product of state-of-the-art technologies and as a result the athletes who are the vanguards of the deployment of this new technology are producing performances that would have been considered impossible twenty years ago.

It can be argued that this sporting technology has advanced with three aims in mind: to produce better performances; to increase the comfort for an individual, athlete or otherwise; and to enable an improvement in efficiency of movement. Advancement is most evident on the track, but also in field events where athletes

with amputations have the option of competing as standing athletes or as athletes who use throwing frames (6). Traditionally, a large percentage of track and field athletes with full or partial leg amputations have for reasons of comfort competed from a wheelchair. The use of flex-foot technology that is used instead of the old-fashioned prosthesis, where flexion of the ankle was either mechanical or non-existent, is universal at the highest level of Paralympic sport. It is this technology that has quite literally catapulted Pistorius and Rehm to be the public face of the contemporary Paralympic movement. The advances in technologies of both prosthetic limbs and wheelchairs allow these movement technologies to become productive extensions of their bodies. These athletes are all individuals who are accustomed to using these technologies for mobility, to the degree that moving becomes habitual, and allows them to develop a hybrid body (7). In the case of sport, both artificial limbs and wheelchairs can be seen as a form of prosthesis. The term prosthesis is Greek for an addition designed to remove physical stigma.

There is a desire to 'create' the normal and at the same time allow individuals to be more mobile and therefore independent. In the context of sports participation as well as day-to-day mobility, one of the problems associated with traditional technology is the development of pressure ulcers and painful stumps that develop where the prosthesis joins the body (8) but as these technologies advance, these medical ailments become less commonplace. The treatment of the nexus between the prosthesis and the body has developed at pace with the actual replacement limb. Today, the top of the range 'flex foot' legs are built around the individual's stump and are secured in place by a vacuum seal device which often includes gel padding which greatly reduces the risk of injury from swelling and friction (9). We now turned to the notion that such developments and their celebration signal a 'technocratic ideology' that Shogun has suggested is becoming increasingly pervasive within the Paralympic movement (10,11).

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