International Encyclopedia of Rehabilitation

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Scoliosis Rehabilitation

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Abstract

Historically the treatment options for Adolescent Idiopathic Scoliosis (AIS), the most common form of scoliosis are; exercises; braces and surgery. Methods and modules of rehabilitation are described in more detail within this review. Out-patient physiotherapy (PT), In-patient rehabilitation and correct braces used in the rehabilitation of patients with scoliosis should be pattern specific as described to be current *'Best Practice'*. Evidence has been gained to support conservative scoliosis management on level Ib / IIa: One short-term RCT exists to support out-patient PT, a prospective controlled study was found to support Scoliosis In-patient Rehabilitation. One prospective multi-centre study, a long-term prospective controlled study and a meta-analysis have been found to support bracing. No controlled study, neither short, mid nor long-term, was found to reveal any substantial evidence to support surgery as a treatment for this condition.

In the case of scoliosis and pain certain programs of physiotherapy and bracing are applied, a description of which is included within this paper.

Scoliosis rehabilitation, unlike surgery, aims to improve the signs and symptoms of scoliosis. Not only curve magnitude, but also functional impairment like reduced general mobility and reduced vital capacity can be improved upon by physical methods. Back pain cannot be regarded as a consequence of scoliosis, however there is evidence that this can be improved by a specialised rehabilitation program and specific bracing technology.

Not only an improved physical, but also an improved psychosocial outcome can be achieved by utilising current standards of scoliosis rehabilitation, which have been described as being the current *'Best Practice'*.

Background

For many years, medical and scientific literature of the spinal community has dismissed every type of exercise as a legitimate avenue to employ in the treatment of scoliosis (Hawes 2003). Virtually every review of scoliosis treatment published in recent decades either states explicitly that exercise is of no use in the treatment of scoliosis, or does not mention it at all. With the exception of physical therapy, which occasionally is mentioned in the peer-reviewed spine literature as a way to help patients cope with the complications of brace and surgical treatment, avenues that involve physical methods of treatment by a professional have tended to be ignored (Hawes 2003).

In Continental Europe especially in Germany, a conservative treatment approach is pursued actively from the time of diagnosis (Weiss 2003, Weiss 2007a). In adolescence, this approach includes out-patient physiotherapy to start with at 15° according to Cobb during the pubertal growth spurt. Scoliosis intensive rehabilitation has been recommended for curvatures starting at 20° to 30°, with or without bracing, depending on prognosis. For adult IS, out-patient physiotherapy is offered for curvatures of 30° to 40° with moderate pain. Physiotherapists from different regions are trained, so that patients have the option of continued out-patient treatment close to their residence. For adult patients with curves over 40° in association with cardio-respiratory functional impairment and pain, in-patient rehabilitation may be recommended.

The indications for conservative scoliosis management and rehabilitation can be seen in their complete form in the SOSORT guidelines paper, published in scoliosis (Weiss et al. 2006c, http://www.scoliosisjournal.com/content/1/1/5).

Scoliosis Intensive Rehabilitation

Rehabilitation employs an individualized exercise program combining corrective behavioural patterns with physiotherapeutic methods, following principles described by Lehnert-Schroth (2000) and Weiss (Weiss 2007a, Weiss and Maier-Hennes 2008). The three-dimensional scoliosis treatment is based on sensomotor and kinesthetic principles and its goals are like the goals of out-patient treatment (1) to facilitate correction of the asymmetric posture, and (2) to teach the patient to maintain the corrected posture in daily activities (Weiss and Maier-Hennes 2008).

The treatment program consists of correction of the scoliotic posture with the help of proprioceptive and exteroceptive stimulation. Central to the individual and group exercise programs is therapist assistance (Figure 1), who supervise all exercises and provide exteroceptive stimulation needed to obtain the desired corrections. Depending on individual curve patterns, the patients are assigned to special exercise subgroups making the program for the individualised to suit the patient's needs (Figure 2). Development and maintenance of the corrected posture is facilitated using asymmetric standing exercises designed to employ targeted traction to restore torso balance and mobility.

The "Best Practice" rehabilitation program uses a certain methodology in order to address all clinical aspects of the patient's deformity:

- physio-logic® exercises (correcting the sagittal profile, Weiss and Klein 2006)
- 3D made easy® exercises (3D program easy to acquire for small curves, Weiss, Hollaender and Klein 2006)
- Pattern specific activities of daily living (specific ADL, Weiss and Hennes 2008) and
- Schroth exercises (Lehnert Schroth 2000)

The bigger the curve, the more the Schroth exercises are performed because this method of treatment is most effective in curvatures of more than 30° (Weiss et al. 1997). On the other hand curvatures between 15 and 25° do not necessarily need the Schroth program, which is rather complex and not very easy to learn, when there are other specific approaches available, which are easier to learn and already have been tested in the environment of an in-patient rehabilitation centre (Weiss and Klein 2006, Weiss, Hollaender and Klein 2006).

The primary goal of specific rehabilitation is for patients to be able to assume their personal corrected postural stereotype, independent of the therapist and without mirror control, and to maintain this position in their daily activities. Recommended at-home follow-up treatment includes three to four exercises for 30 minutes daily in order to maintain the improved postural balance. Therapists throughout Germany, Spain, Austria, Switzerland, United States, Turkey and Israel have received training in the Schroth approaches so that local out-patient resources are available. In cases of reported pain, curvature progression, or pulmonary symptom development repeat intensive rehabilitation treatment is available by referral from primary care physicians, paediatricians and orthopaedic specialists (Weiss et al. 2003, 2003, Weiss 2003).

Latest developments

The change from the classical *'teacher / pupil'* setting to modern concepts of learning seem to allow a reduction of total training time of in-patient scoliosis rehabilitation to 14 days or even less, without reducing the effectiveness of treatment (Weiss et al. 2006a). The role of the physical therapist changes from being that of a teacher to a supervisor, who acts as a catalyser to empower the active role of the patients and to foster the ability of the patients to develop their individual treatment protocol by themselves via experiential learning.

This new concept called *'Integrated Scoliosis Rehabilitation (ISR)'* is currently applied (Weiss 2007a) at the first few centres. *'Integrated'* is used to describe the teamwork of all professionals *'acting as one'*. The physician, physical therapist and (where available) psychologist are integrated in each others´ work and are acting together in synchronicity in the diagnosis and treatment.

The limitation of this concept is that it is restricted to patients where scoliosis is the major problem. Patients with neuromuscular scoliosis and patients with a significant reduction of learning capability cannot be included in this treatment. The majority of the scoliotic population however, patients with idiopathic scoliosis (80 – 90% of all scoliosis) can easily be treated using the ISR - approach.

As has been shown, Scoliosis Intensive Rehabilitation (SIR), in its original form can no more be regarded as being effective when rehabilitation times have been reduced to 3-4 weeks, only (Weiss and Goodall 2009). The incidence of surgery for the patients receiving this in-patient program (Weiss, Weiss and Schaar 2003) is comparable to out-patient approaches (Maruyama et al. 2003, Rigo, Reiter and Weiss 2003), although the different studies have patient samples which are not necessarily comparable. The development of such research means that more intensive out-patient approaches seem more appropriate when one considers; time efficiency and new teaching approaches including experiential learning (ISR), as described within the book on "Best Practice" treatment (Weiss 2007a). Therefore an in-patient program, such as SIR is today regarded as outdated. Actually three day intensive programs based on the "experiential learning" approach of ISR are provided in the US, UK and in Germany at the first authors centre.

High correction bracing

Brace treatment has also to be regarded to be an essential part of scoliosis rehabilitation. Prevention of curve progression, improvement of clinical appearance or the improvement of the curve itself, (Weiss and Rigo 2008) are clear aims of rehabilitation.

Two factors have emerged as the main parameters of successful brace treatment. Goldberg and co-workers (2001) cite two references in which good patient compliance with bracing corresponded with favourable outcomes (Emans et al. 1986, Fernandez-Feliberti et al 1995). However, the actual extent of the corrective effect is also described as an essential criterion in successful bracing. Based on a review of the literature, we confirmed as early as 1995 a direct positive correlation between the primary corrective effect of an orthosis and the end result (Weiss 1995). The importance of this effect is supported by a study from Mellerowicz et al. (1994) and by a study from Landauer et al. (2003), in which they independently conclude that compliance and the primary correction effect in the brace are the two most important variables associated with good brace outcomes. The treatment of AIS however serves to change not only the secondary symptoms of scoliosis and the X-Ray result (Figure 3) but – most important to many of the adolescents – also aims at an improvement of the clinical / cosmetic signs of the deformity (Figure 4).

Today it is possible to design specific braces for individual curve patterns without plaster, which – due to the balance of pressure zones and voids – are comfortable to wear. For the treatment with a pattern specific high correction brace using the CAD-technique (Regnier system-Chêneau brace, Rigo-Chêneau brace, the LA brace®, the Sagittal Augmented Chêneau (SAC) brace® and Chêneau light® brace) certain static and also dynamic values describing the deformity and the directions of correction are necessary to measure, as well as to document new X-rays (full spine in standing position) and clinical pictures of the trunk (including the back, frontal and lateral views).

After this procedure the data is sent via a secure internet network to the experts who first determine the curve patterns according to classifications used in order to choose the appropriate model in relation to the curve patterns, the patient's age and curve severity. Based on the static and dynamic measurements of the patient a foam model is produced and according to all of the factors above the brace is finally constructed (Figure 5).

Results of scoliosis rehabilitation

Physiotherapy / Rehabilitation

Case report studies have demonstrated that measurable positive changes in the signs and symptoms of IS are correlated with physiotherapy treatment (Weiss 1991, Weiss 1993). Among over 800 patients, nearly every case revealed a small but significant improvement in chest expansion and a 14-19% improvement in VC after rehabilitation treatment (Weiss 1991). Among 794 adult patients with severe scoliosis, 55% exhibited at least one sign of right ventricular strain at admission and by the end of the study only 12% exhibited signs of impairment. Vital Capacity improved by 250 ml in the same adult population (Weiss 2003).

Among 107 patients mean Cobb angle decreased from 43 to 39 degrees, with improvements of up to 20 degrees in individual patients after in-patient rehabilitation (Weiss 2003).

Studies also have demonstrated significant improvements in pain (Weiss 1993, Weiss et al. 1999, Weiss 2003) and psychological distress (Weiss and Cherdron 1994, Weiss et al. 2006d, Freidel et al. 2008) in response to rehabilitation.

Results of a preliminary study were consistent with the possibility that incidence of progression among 181 patients treated with physiotherapy during the late 1980's was significantly less than the incidence that would be expected based on natural history surveys (Weiss 2003).

Another study to test the hypothesis that physiotherapy-based intervention can reduce incidence of progression in children with IS was performed 2003 with materials from 1989-1991 and an untreated control group (Weiss et al. 2003). A follow-up of the outcome of two prospective studies used the outcome parameter, incidence of progression ($\geq$5°), in treated and untreated patient groups matched by age, sex, and degree of curvature at diagnosis, were included factors. A six-week scoliosis in-patient rehabilitation program offering patient-specific physiotherapy including intensive therapist-assisted exercise in diagnosis-matched groups was the method of treatment. The Incidence of progression in groups of untreated patients ranged from 1.5-fold (71.2% vs 46.7%) to 2.9-fold (55.8% vs 19.2%) higher than in groups of patients treated with rehabilitation, even when rehabilitation-treated groups included patients with more severe curvatures. The differences recorded were highly significant. The results of this study indicate that a supervised program of exercise-based therapy can reduce the incidence of progression in children with IS.

The results of this study however, have not been reproduced with patient samples undergoing in-patient rehabilitation with treatment times reduced to 3-4 weeks (Weiss and Goodall 2009).

At last a RCT on physiotherapy from China provides the physical medicine and rehabilitation approach to scoliosis with level Ib evidence and a level A recommendation (Negrini et al. 2008). Interestingly the approach used in this study seems not specific, however due to possible translation problems this issue should be investigated more closely in the near future.

Braces

Bracing as a part of rehabilitation appears to have a level B recommendation (IIa level of evidence), while surgery in the treatment of scoliosis is not supported by prospective controlled outcome studies (Weiss 2007b and c, Weiss 2008a, Weiss and Goodall 2008). Therefore a medical indication for surgical intervention cannot be derived from actual literature for patients with AIS, and in relation to other aetiologies recently has been scrutinised also (Weiss 2008 b, Weiss and Bohr 2008).

It seems rather important to apply only the best possible standards, considering the fact that some of the children and adolescents under treatment sacrifice their quality of life to the brace for years (Weiss 2007a). The best possible standard can be expected in specialist driven bracing systems with the likelihood that the most appropriate brace will be applied in the individual case.

We do know, that outcome of bracing is dependent on the in-brace correction achieved (Hopf et al. 1985, Weiss 1995, Landauer et al. 2003, Kessler and Bowman 2007). Therefore to increase efforts to improve in-brace correction (Weiss et al. 2007b) and compliance (Weiss et al. 2007a) seems a worthwhile endeavour. Clear evidence has been achieved for the use of Boston brace in a multi-centre prospective controlled study performed by the Scoliosis Research Society (SRS) (Nachemson et al. 1995). As the Chêneau derivates actually applied correct better than Boston type braces (Weiss and Rigo 2008), with this bracing technology better outcomes may be expected. This will be made comparable when the SRS criteria for bracing (Thompson 2008) will be applied in future prospective studies on bracing.

General aims of scoliosis rehabilitation

The application of intensive physiotherapy alone cannot be regarded as the most important factor for a successful outcome and a preservation of the results achieved after the program.

The best exercise program available can only be performed for 30 minutes at home, which seems to be a small amount of time compared to 24 hours of each day.

So we have to aim at a restructuring of the activities of daily living (ADL).
For a patient with scoliosis it feels comfortable when the curve stays un-corrected, the corrected curve is felt to be inclined. Therefore a patient will not automatically acquire the corrected posture easily and time is needed to get used to this new postural feeling (Weiss et al. 2006a).

To unload the curve during the day the ADL have to be changed according to the curve pattern of the individual patient in lying, sitting and standing postures.

For the patients with significant curvatures clinical appearance can be a problem. Specific rehabilitation therefore provides a safe space to learn to cope with the deformity and thereby to improve self esteem (Weiss and Cherdron 1994, Freidel et al. 2002a and b, Freidel et al. 2008). Coping with the deformity, with treatment (brace) and pain as well during rehabilitation may also be supported by psychologists leading group sessions and offering individual sessions as well. This approach has shown to be successful with improved scale values in scoliosis patients´ months after being back home again (Freidel et al. 2008).

General aims of scoliosis rehabilitation should be:

1. Alteration / correction of ADL
2. Coping with the deformity
3. Coping with treatment
4. Coping with pain

Scoliosis and pain

In actual fact scoliosis does not automatically induce spinal or low back pain [LBP] (Asher and Burton 2006). A study with over 2000 scoliosis patients with pain reveals a lack of correlation of pain intensity and curve magnitude (Weiss et al. 1999). In clinical practice however one has to distinguish between what we now call postural low back pain [PLBP] (related to the loss of lumbar lordosis) and instability low back pain [ILBP] (related to a sagittal instability L4/5 or L5/S1 as in symptomatic spondylolisthesis). Also a combination of both categories rarely is possible. Simple physical tests are described to distinguish clinically between the two main categories (Weiss 2005, Weiss and Werkmann 2009b) (Figures 6a and b).

The strategy for physical rehabilitation differs essentially and can be separated into two categories:

Chronic postural low back pain (PLBP)

Re-lordosation techniques (Machado et al. 2006, Weiss and Klein 2006, Browder et al. 2007) have to be applied in PLBP (about 90% of the LBP population) to improve or correct the sagittal profile aiming at a balanced ‘S’ when viewed from lateral. Bracing strategies should also be specifically aiming at the anatomical sagittal profile (Bernhardt and Bridwell 1989) and therefore should increase lumbar lordosis with an apex on the L2 level (Weiss 2005, Weiss and Dallmayer 2006b, Weiss et al. 2006b, Weiss and Werkmann 2009a and b). This bracing strategy is implemented in the physio-logic® brace, which has been shown to decrease intensity of chronic LBP immediately in most of the cases (Weiss 2005, Weiss and

Dallmayer 2006b, Weiss et al. 2006b) (Figure 7). A recent study shows the physio-logic® brace to enable pain reductions also in mid-term (Weiss and Werkmann 2009a).

Chronic instability low back pain (ILBP)

Techniques of de-lordosation have to be used for ILBP to support the instable segment by horizontalisation of the disc space L5/S1 or, if needed L4/5. Of course we have to recognise that this is a non-physiological posture, however pain reduction in those cases with symptomatic sagittal instability is the first aim (Weiss and Werkmann 2009b). Strengthening of the abdominal muscles and postural education regarding the optimum pelvic alignment to reduce sagittal shifting forces are the main focus in these conditions about 10% of the LBP population experience (Weiss and Werkmann 2009b).

Bracing strategy for this condition consequently leads to a reduction of lumbar lordosis with the help of a simple 3-point system (spondylogic® brace) as can be seen on figure 8 (Weiss and Dallmayer 2006a, Weiss and Werkmann 2009b).

It seems that the artificial posture adolescents with symptomatic instability in the lumbo-sacral junction (eg. Symptomatic spondylolisthesis) acquire leads to a scoliosis in some cases because of the reduction of the sagittal profile, which is supposed to destabilise the segmental configuration and its function (Burwell 2003).

The effectiveness of classification-based low back pain programs, is yet to be established with a high level of evidence (Machado et al. 2006).

In the individualised physical rehabilitation programs for low back pain, restoring function is the primary goal before specific bracing is offered, knowing that a loss of mobility correlates with an increase in pain intensity (Deviren et al. 2002).

Rehabilitation after scoliosis surgery

Rehabilitation after scoliosis surgery will usually not be necessary post intervention. First solid fusion is necessary before thinking of an advanced rehabilitation program including mobilisation techniques.

Unfortunately many patients appear to have - sometimes severe - back pain after surgery, they did not experience prior to the surgery (Hawes 2006). In many cases this kind of post-surgery back pain can be improved during rehabilitation (Weiss 2002). However even if there is no severe back pain after surgery the junctional zones should be stabilized by intensive physiotherapy to prevent early instability in these segments. As Renshaw (1988) pointed out, it is only a matter of time that the instrumentation fails, instability occurs (Figure 9) and a re-operation is necessary (Hawes 2006). Muscular stability should be able to reduce the rate of patients with instability and pain after surgery although at this time there is no evidence in literature to support this assumption. Therefore in post-surgery rehabilitation we aim at a stabilisation of the junctional areas (fusion / free segment regions), at a reduction of pain severity and an improvement of rib mobility in patients with reduced lung function after undergoing thoracic fusion.

Discussion

Many different methods of physiotherapy are described in literature, and many different braces are on the market today. But it seems reasonable to discuss the result of “Best Practice” management in comparison to these other approaches.

If we regard a combination of "physio-logic®", "3D-exercises made easy", and "Schroth" as "best practice" in physiotherapy we will have to compare the described treatment strategies to other methodological approaches:

- Methode Lyonaise / SEAS
- Dobosiewicz
- Side Shift

Methode Lyonaise

The Lyonaise Method aims at 3-D postural correction and an improvement of skills the patient needs for autocorrection, however the exercises are not performed asymmetrically. The postural correction therefore, is not comparable to that achieved by use of the Schroth technique (Weiss 2007a). The sagittal correction sometimes, like in the SEAS treatment, is treated with the help of certain exercises in a brace. Without the lordosing counteraction of the lumbar pad many exercises from the Lyonaise school lead to a total kyphosis which cannot be regarded as being effective (Weiss 2007a). A prospective study with an untreated control group is not available for the Lyonaise Method, but there is a retrospective controlled trial (Mollon and Rodot 1986).

SEAS

The SEAS (Scientific Exercise Approach to Scoliosis) program as presented by Negrini et al. (2006a and b) are derived from the Lyonaise school. In a personal communication, Negrini (2004) reported concerns against mobilisation, however the so called SEAS 02 exercises, allegedly developed in 2002, in the year 2006 contain mobilisation techniques (Negrini et al. 2006a and b).

Up to now there are no prospective outcome studies showing the SEAS program to reduce the progression risk or improve other signs and symptoms of scoliosis.

Many papers have been published by the authors. These do not necessarily contain useful information: Comparing two programs without evidence in a randomized controlled study does not seem to make sense (Negrini et al. 2006a). Furthermore when the ADL-exercises described by the Italian group need months to be acquired by the patient, as has been reported by Negrini et al. (2006b) it is the question as to whether it is worthwhile at all to teach them.

Furthermore Negrini et al. 2008 reported on the rate of surgery in a retrospective review and described the program as being successful. Considering the fact, that the average patient from this sample according to the SOSORT guidelines would not need any treatment at all, the study would not seem worthwhile performing (Figure 10). The Italian group around Negrini describes the SEAS program as a specific exercise program (Zaina et al 2009), however it does not describe different approaches to individual curve patterns, nor are specific exercises documented in any of the papers from this group.

The SEAS program, therefore is not yet clearly defined, it therefore cannot be regarded as a specific program and it should not be regarded as evidence-based, when a prospective study with an untreated control group is yet to be published. The number of papers on this program does not correlate with a sufficient clinical documentation of the treatment approach or with real scientific results.

Dobosiewicz

The Dobosiewicz Method is not well described in international literature. Internationally little is known about this method of physiotherapy. One aim of this method is the rekyphosation of thoracic flatback. During the exercises the patients are forced into a forward bending position leading to a kyphosation of the whole spine (Dobosiewicz et al 2006). How the relordosation of the lumbar profile is established is still an open question for this method of treatment. The only scientific investigation published so far seems questionable, when the average patient from the sample presented would not be treated at all according to our guidelines (Dobosiewicz et al. 2006). In this sample an average progression of 5° has been achieved during the period of observation, while in a comparable sample of patients treated according to the Schroth protocol an improvement of Cobb angle as well as vital capacity has been reported upon (Otman et al 2005). So the Schroth approach clearly should be favoured over the Dobosiewicz approach (Figure 10).

Side Shift

The Side Shift technique addresses the deformity in the frontal plane only. Meanwhile we have gained evidence that the postural correction can be improved when lumbar lordosis as well as thoracic kyphosis is restored (Weiss 2005, van Loon et al. 2008). The frontal deviation can be regarded as the secondary deformity (Deacon et al. 1984, Tomaschewski 1987, Weiss 2005, van Loon et al. 2008) and for this reason Side Shift exercises have to be regarded as the second choice.

Nevertheless side shift exercises are well described clinically in the international literature (Mehta 1986, Maruyama et al. 2002, Maruyama et al. 2008) and results of side shift treatment seem promising (Mehta 1986, den Boer et al. 1999, Maruyama et al. 2003).

Side shift exercises also have a place in the *'Best Practice'* approach (Weiss 2007a) when we aim at ADL training (Weiss, Hollaender and Klein 2006).

Bracing strategies

Also there are a lot of bracing approaches, many of them neglecting the importance of in-brace corrections. As has been shown earlier symmetric braces are worse at correcting than pattern specific asymmetric braces. Outdated procedures are described as the 'latest technology' (Negrini et al 2008) and soft braces are supported by other authors (Coillard et al.), while independent studies have shown that hard braces are superior to soft braces (Weiss and Weiss 2005, Wong et al 2008, Weiss 2008). As can be seen the *"Best Practice"* approach to scoliosis bracing describes braces with demonstrated in-brace corrections and questions the use of braces with reduced quality of standards (Negrini et al. 2008), lacking credibility (Negrini et al. 2008) and contradictory results (Coillard et al).

The Sforzesco brace as described by Negrini et al. 2008 as the latest standard in Italy, like the SEAS exercises, is not well documented upon. The authors do not consider to make in-brace X-Rays to document in-brace correction and prove proper pad adjustment.

The only *result* as demonstrated in this paper as a figure seems to show an alleged correction after brace wearing. In clinically critising the spine as shown on the X-Rays it actually seems more immature after treatment than before, the Risser sign is more mature before treatment and pelvic width is bigger before treatment than after (http://www.scoliosisjournal.com/content/3/1/15/Figure/F3).Therefore this result cannot be regarded as being credible.

Furthermore, the Risser on both x-rays is beyond stage 3 but a stable correction in that stage of maturity is not achieveable. The clinical figure as demonstrated in the upper part does not seem to belong to the radiological example. Considering the breast maturity of the girl demonstrated here, the patient clearly has no indication for bracing.

Although many papers have been presented by the authors on that topic until now, there is neither a clinical or credible radiological improvement documented, nor a real scientific investigation with an untreated control group.

The Boston brace has been shown effective (Nachemson and Peterson 1995, Danielsson et al. 2007) as well as the Chêneau brace (Hopf and Heine 1985, Landauer et al. 2003). Symmetric concepts of bracing can neither be regarded as new nor as efficient. If we treat an asymmetric condition with symmetric braces we will never gain correction effects as have been shown when asymmetric braces are used aiming at mirroring of the deformity. Therefore the *'Best Practice'* approach can be described as an asymmetric highly corrective approach in physiotherapy and bracing as well.

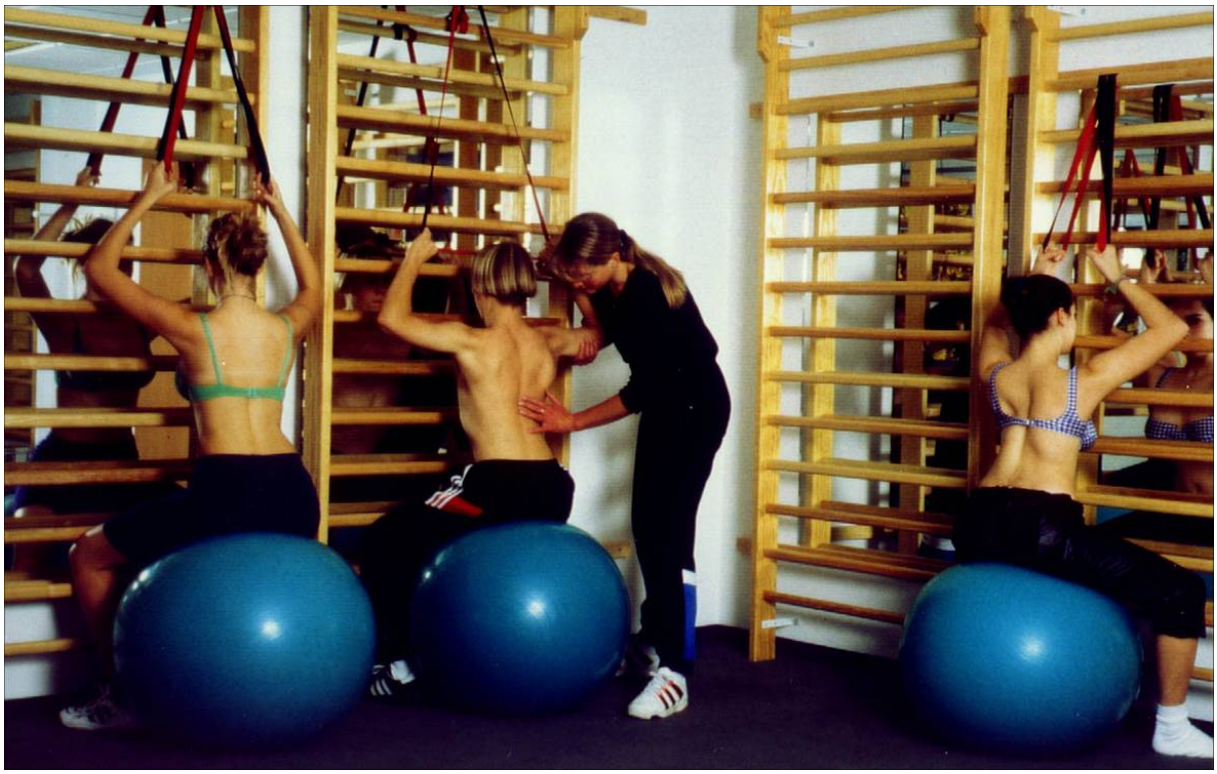
Conclusion

Scoliosis rehabilitation aims at an improvement of signs and symptoms of scoliosis, which have not yet shown to be improved by surgery (Hawes 2006, Hawes and O´Brien 2008). Not only curve magnitude, but also functional impairment like general mobility and reduced vital capacity can be improved during in-patient rehabilitation (Weiss 1991, Weiss 1993, Freidel et al. 2008). Back pain cannot be regarded as a consequence of a scoliotic curve, however there is evidence, that this can be improved by a specialised rehabilitation program (Weiss 1993, Weiss et al. 1999, Freidel et al. 2008) and specific bracing technologies (Weiss et al. 2006b, Weiss and Dallmayer 2006b, Weiss and Werkmann 2009b) even if it may be the consequence of scoliosis surgery (Weiss 2002). Not only an improved physical, but also an improved psychosocial outcome (Freidel et al 2008) can be achieved when modern asymmetric, highly corrective standards of scoliosis rehabilitation are applied which have been described as being current *'Best Practice'* (Weiss 2007a).

Unfortunately much literature has been produced which is poor in quality, with patients who do not need treatment at all (Figure 10), studies comparing non evidence-based approaches to each other and studies lacking proper documentation of the approaches presented. The *'Best Practice'* approach (Weiss 2007a) however, is supported by valid scientific data and has been documented with numerous clinical and radiological examples. It has been described at length in order to allow a reproduction of exercises and bracing strategies, courses are available for physiotherapists, physicians and orthopaedic technicians so as to allow a fast and secure distribution of the knowledge gained so far. Therefore the *'Best Practice'* approach can be regarded to be the gold standard of conservative treatment of patients with spinal deformities today.

Figures

Figure 1

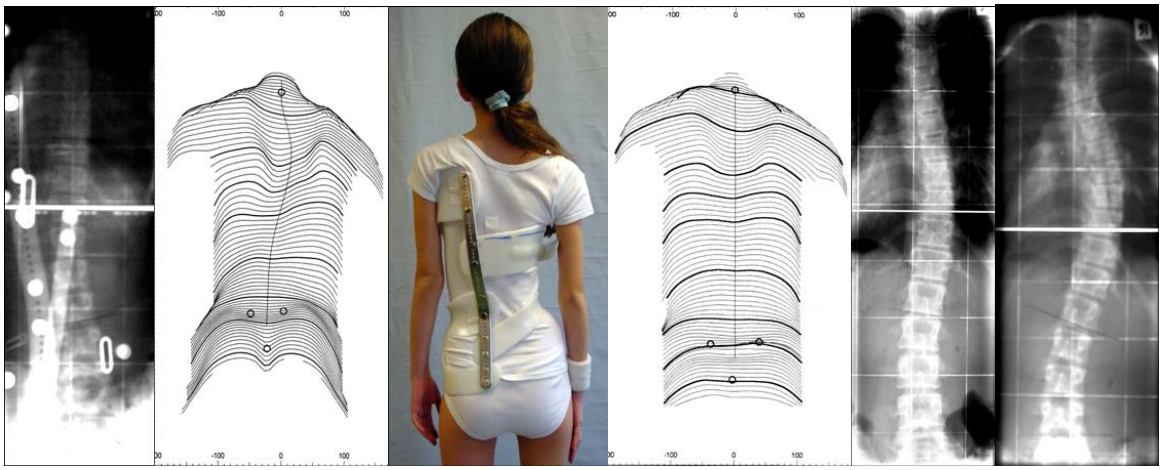


During the regular group sessions, which are curve pattern specific, one therapist cares for 12-15 Patients also individually while having an eye on the whole group going on with the autocorrection exercise currently on the plan.

Figure 2

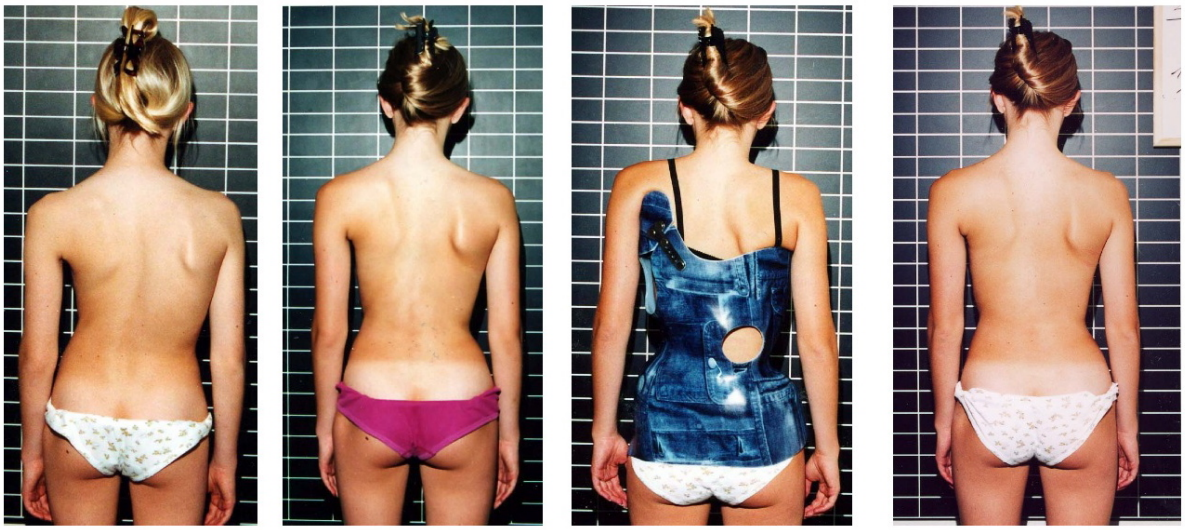
During the individual exercises in between the regular closed group sessions, the patients work on 3 – 4 exercises which are most important to perform at home. In this case of a right thoracic curve active overcorrection is possible.

Figure 3



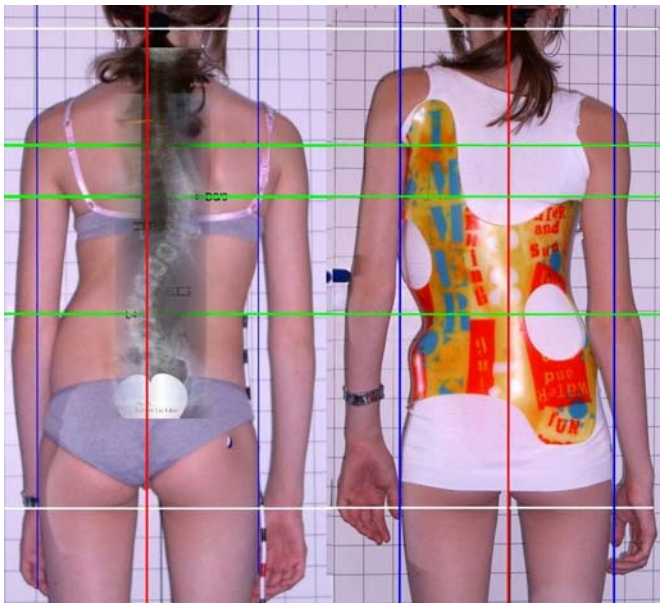
Patient starting at the age of 11 with a thoracic curve of 38°, which has been overcorrected in the Chêneau light® brace (*left*), after two years of treatment with 19° and a very good physical appearance (*middle right*) as compared to before treatment (*middle left*).

Figure 4



Patient with 36° at the age of 13 years with severe decompensation (*left*), after treatment with a custom Chêneau brace for two years she had a re-balanced appearance (*middle*) and after one year without brace the balance has been kept and the curve is down to 26° (*right*).

Figure 5



A CAD/CAM Chêneau brace of actual standard clearly showing the mirroring of the deformity in the brace.

Figure 6

Sagittal realignment test (SRT) lying (Weiss 2005) to estimate as to whether a patient will benefit from physio-logic® exercises or the physio-logic® brace. In the positive case this test will immediately reduce chronic LBP (PLBP).

Sagittal realignment test (SRT) in standing position (left). In the positive case this test will immediately reduce chronic LBP (PLBP), and the delordosation test (DT) (right). In the positive case this test will immediately reduce chronic LBP if this is due to instability(ILBP).

Figure 7

physio-logic® brace improving chronic low back pain in this patient with spinal stenosis and increasing walking ability drastically from 500 steps to 12000 steps.

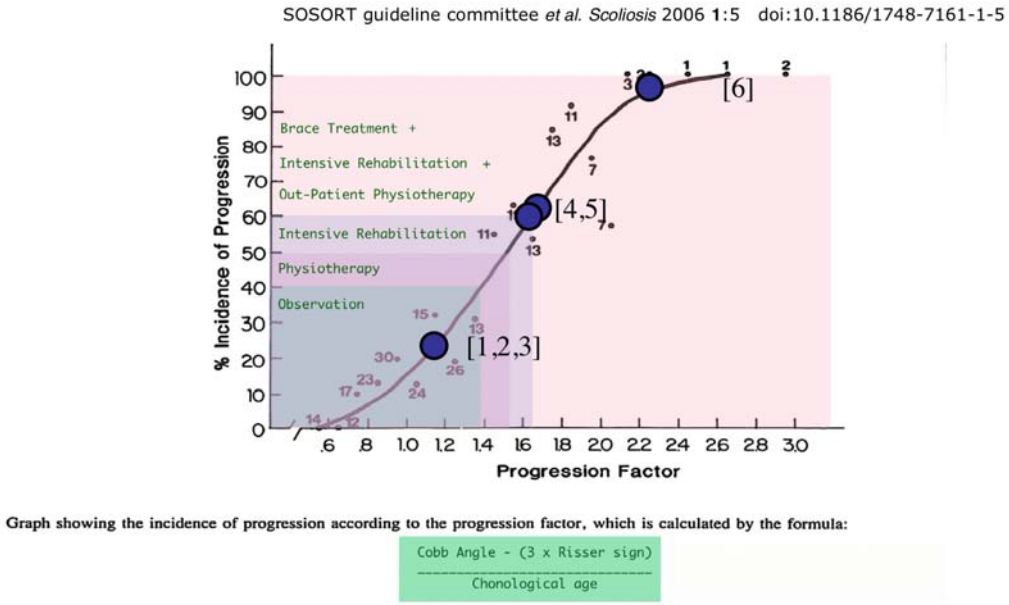
Figure 8

spondylogic® brace in a patient with a scoliosis of less than 25° and a symptomatic spondylolisthesis. Immediate pain relief was dramatic and the symptoms of spinal stenosis in this 14 year old girl have been reduced drastically as well. Mid- to long-term effects however are not yet reported for this brace.

Figure 9

Patient with early onset scoliosis with rod brakeage after re-operation. Improving stability via muscles and preserving stability of the lumbosacral junction will be the main aims of rehabilitation in this case. As thoracic fusion has been performed as well, increasing rib mobility is another aim (Weiss 1991).

Figure 10



([1] Dobosiewicz et al., [2] Otman et al., [3] Negrini et al., [4] Rigo et al., [5] Maruyama et al. and [6] Weiss et al.)

Material of different studies describing the outcome of physiotherapy in the treatment of scoliosis. Three papers provide patient samples where the average patient would not need any treatment at all (Dobosiewicz et al. 2006, Otman et al. 2005, Negrini et al. 2008). While the Dobosiewicz sample showed an increase of curvature during the time of treatment, the Otman sample improved using the Schroth access. When aiming at finding evidence for physiotherapy only patient samples should be used with a risk for progression of > 60% as can be seen in the other samples.

We have calculated patient samples of less than 13 years (mainly girls) as being Risser 2, more than 13 years as being Risser 3 and more than 14 years as being Risser 3,5 at average. Even if we would calculate the risk for progression in the published sample by Negrini of mainly mediterranean girls with a Risser stage of 2, still no treatment indication was given.

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