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MEMORIES BY A MYOLOGIST

Requiem

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"In never considering neuromuscular disease to be untreatable, Yves Rideau has found ways to ameliorate every aspect of these conditions. His work has resulted in immeasurably enhancing the quality of life of his patients". This dedication included into the *Guide to Evaluation in Management of Neuromuscular Diseases*, 1999, made by a coworker who studied in Poitiers from 1981 to 1983, summarizes the content of this paper.

Key words: Duchenne muscular dystrophy, rehabilitation, surgery, ventilation

Introduction

"No longer knowing where the sun rises, nor where it hides underground, we must hurriedly deliberate" (according to The Odyssey, Song X, verses 190-192, Aiaié, Circé's field).

"I", the personal pronoun, is seldom used in medical publications, particularly of the statistical variety. However when we strive to explain the intimately individual meaning of a lifelong commitment that is drawing to a close, its use is to be preferred. I am also determined, on this unique occasion, to thank and honor all those who assisted me, often discreetly, and thereby allowed me to move forward as I tried to comprehend a particularly difficult pathology.

My initial contact with muscular dystrophy, especially with the Duchenne type (DMD), symbolized the abnegation of the caregivers of the time (Fig. 1). The isolation of the diseased children in specialist centers constituted the basis of the recommendations in France during the 1970s. For this reason, five of them were permanently hospitalized in the medical rehabilitation department of Poitiers hospital, on the hope that contemporary techniques could counteract some of the disease's deleterious effects. The first lesson received at that time was the result of a family's revolt: "Where do you get the right to deprive my brother of what's left of his freedom during the little time he has still to live?". My response consisted in stressing the exigencies of an optimal medical care. Shortly thereafter, the boy passed away. That was when I realized that I needed to modify my approach and my techniques.

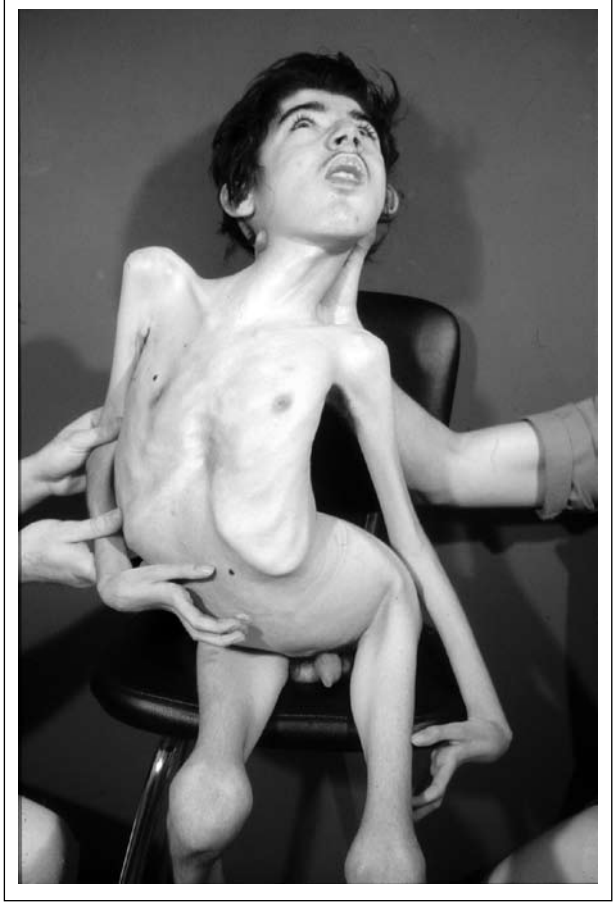

Figure 1. Body status seen in the 1970s in an adolescent suffering from a very rapidly evolving DMD; death at the age of 16 years.

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The rare studies insisting on a comfortable life for DMD patients originated for the most part in the United States. They carefully attempted to prolong the ambulatory stage by bracing, after a surgical correction which was contraindicated in France. The eminent defender of this kind of management in the 1960s, Paul J. Vignos, was in charge of the one of the medicine departments of the University of Cleveland, Ohio. The initial rule that he promulgated, firmly excluded prolonged bedrest: "The duration of enforced immobilization in bed or in a wheelchair should be kept to a minimum during an intercurrent acute illness […] This allows an active physical therapy program to be prescribed that will help minimize disuse atrophy […] This prescription, for such a combined activity program, should be given to neuromuscular disease patients if it is anticipated the illness will require bedrest for longer than 4-5 days".

I was fortunate enough to be introduced to this country in 1972 thanks to professor A. Cournand, from the Columbia University, winner of a medicine Nobel Prize for his work in the cardio-respiratory area and for his discovery of cardiac catheters. Following my requests, he informed me that I needed to start by observing carefully the problems I wished to solve, without thereby neglecting the patient in his integrity. He affirmed that "when knowledge of the clinical course became clear, therapeutic decisions would come much more easily". He then advised me to visit a specialized unit devoted to respiratory assistance in Goldwater Memorial Hospital, which was part of the New York University Medical Center. In that I saw, among many poliomyelitis patients, three DMD bedridden boys surviving thanks to permanent assisted ventilation and supervised by M. Solomon. Exchanges of concepts subsequently occurred; in 1973, Solomon came to Poitiers to gather information on the procedures we were employing at that time.

A general consensus underlined the inexorable characteristic of the disease. Knowledge of the condition of the wheelchair-confined patients was minimal. That is why I spent long periods in Montreal for one decade, where I had the possibility to regularly supervise one hundred patients who never benefited from even the slightest palliative management. They were allowed to live in accordance with their wishes and consequently they incarnated the natural course of the disease. This activity led to my residing in Montreal from 1977 to 1979, at the University Rehabilitation Institute. During this fruitful period, I studied the management practices, implemented in the main institutions, that respected the principles put forward by G.E. Spencer and P.J. Vignos (e.g. m. tibialis posterior transfer, by D.A. Gibson in Toronto and J.D. Hsu in Los Angeles, taught to me by my dear fellow Louis Roy in Quebec; exceptional recourse to scoliosis surgery, also in Toronto and Los Angeles). My stay in Montreal was much more important for me, because, in collaboration with Raymond Lafontaine, a well-experimented pediatrician, we created in 1978 the first local myopathic clinic, at the Saint Justine Hospital. His vision on the handicaps was a revelation for me, and I wish to quote him: "Of course, correction of a physical impairment is important, but it does not avoid the disappointment of a child who sees his strength continue to diminish. What matters most is to teach him how to accept his disability. The true way of reaching this goal consists in enabling him to develop all his intellectual faculties in such a way as to lead his life on his own". In order to respect his advice, it was first of all necessary to refute the non-reversing fatal prognosis of DMD patients, which was far from being the case at that time.

For the recognized authorities on neuromuscular diseases, many of whom were English, the promise of survival was unthinkable:

- "Tracheostomy or long-term ventilation, even on an intermittent nocturnal basis, are rarely justifiable" (John Walton, in *Disorders of Voluntary Muscle*, University of Newcastle, UK, 1981).
- "Perhaps I might end by saying that I feel strongly that tracheostomy should be avoided in patients with muscular dystrophy. It prevents the patient from being allowed to die in peace when the disease progresses to bulbar failure, which should remain as the final point" (personal letter from a specialist of a Respiratory Unit, Saint Thomas Hospital, London, November 1983).
- "Intermittent positive pressure ventilation with a nasal mask is an important recent advance which may have useful application to Duchenne Muscular Dystrophy […] A potential advantage of ethical importance is that prolongation of life beyond the point of incapacitating bulbar weakness is less likely than with tracheostomy" (in *British Medical Bulletin, Management of children*, Jerry Lewis Neuromuscular Research Center, London, UK, 1989).

These references illustrate the widespread assertion of the conventional wisdom according to which the course of DMD is ultimately prolonged on the muscles commanded by the bulbar, which controls the functions of speaking, eating, deglutition, etc. This condition would clearly not be compatible with therapeutic attempts to prolong life at all cost. It was in that context that I decided to resume my activities in Poitiers, where I was sure to find the goodwill and devotion necessary to progress, even with little outside support, in what constituted a human as well as a medical clinical research. I remain deeply grateful to the entire staff of the rehabilitation medicine department, and also particularly to Ph. Boutaud, M. Morin, B. Potocki, and our first-rate surgeon, Gérard Duport.

It was in that environment that we deemed it indispensable to anticipate first early and efficient correction of orthopedic deformities without bracing, and then recourse

to the use of mechanical respiratory assistance in order to check up the classic restraints of the DMD course. It was more specifically in this framework that a simplified ventilation method, readily accessible to a wide range of patients, was set up in Poitiers using the nasal tract throughout the night for the first time anywhere. The minor clinical decrease of this major vital function observed as of 1984 constituted a genuine and fortunate breakthrough, even if its long term effects were incomplete. The introduction of ventilation as a regular treatment for the sick children was reinforced by two lonely initiatives allowing some assisted patients to return to their homes and even create their own families (Gérard Gatin, Institut Saint Jean de Dieu, Paris and Bud Curran, Executive Office of Human Services, Lakeville Hospital, Massachusetts).

However, the crucial point in our experience, of which the first publication dates from 1986, stipulated the necessary complementarity of the two paths of access, nasal and tracheal, meant according to the severity of respiratory insufficiency. This principle was favorably received internationally, although unexpected obstacles were soon raised in my own country. Fortunately, several outside cooperation programs had already been developed, and they facilitated the normal pursuit of our research. Since the 1980s, one of these exchanges outclassed the others: it was based in Italy, at the University of Naples, Cardiomyology and Myology Service, with the active encouragement of Professors Giovanni Nigro, Lucia Ines Comi and Luisa Politano. This specialist department regularly managed a large number of neuro-muscular patients and made it a constant priority to ease their suffering, thereby ensuring a permanent link with the similar practices pursued in Poitiers. The final phases of our work would have never been carried out over the last ten years without the warm welcome I personally received in what became, in many ways, my intimate second family. The most recent advances achieved during this period should be considered as work carried out by our interconnected energies.

If the preceding chronological sequences are meant to render homage to the unfailing collegiality of those mentioned, they are also aimed at leading to proof validity and transmission of some ultimate principles addressed to as large a population as possible. I can affirm with certainty the following points:

- Effective stabilization of the DMD course is henceforth available, at its adult stage, and this primarily was seen after early protection in the most severe cases of patients affected by this pathology (Fig. 2).
- Use of tracheostomy may and must be rendered easily accessible when indicated since it constitutes the single means of ensuring the effectiveness and safety necessary with regard to the prolongation of the most threatened lives (Fig. 3). On this subject, thanks to our cooperations a new concept has been developed; it is based on an ostium constituting a "tracheal nostril", and it minimizes the presence of a permanent and often stiff tube in the throat (special canula developed with the help of German correspondents, particularly Andreas Hahn, a neuro-pediatrician from the University of Giessen). This project followed a protocol unanimously accepted by the multidisciplinary medical council of Naples in May 2006.
  Our experience conclusively demonstrates that when an alteration of the respiratory function is detected, the therapeutic goal of "giving air to breathe" is obvious [see appendix].
- Up until now the dystrophic process has never extended to all the voluntary muscles at the end of the disease's course. On the one hand, it is clear that progressive muscle weakening involves specific muscles according to an astonishingly constant distribution, and that the weakening increases during the growth stage in each individual. On the other hand, some muscle territories would appear, with equally different distribution, to be spared, for instance those in relation with the *troncus encephalicus* and the *perineum sphincters*. The notion of an implacable and permanent tenet of the disease is consequently inaccurate. Besides, it does exist neglected variations

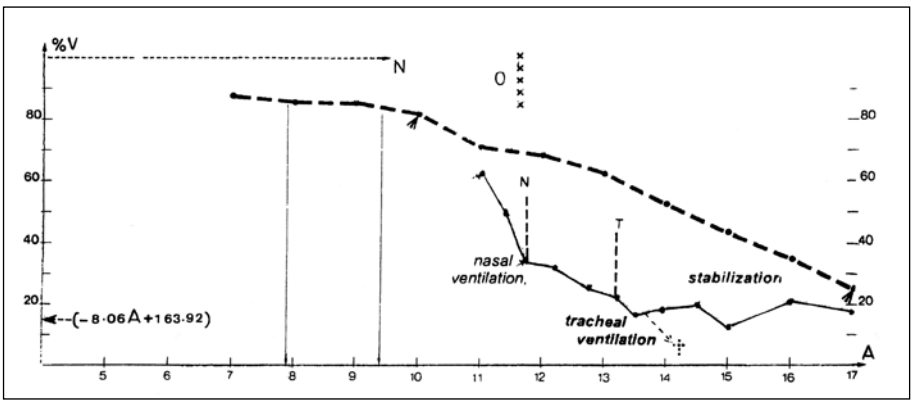


Figure 2. Diagram of the modified course of a particularly severe DMD case (the dotted line represents the evolution on a non-treated control group). Life expectancy was particularly short, in spite of nasal ventilation and other palliative measures (o). Intermittent anticipated tracheal ventilation was proposed for the first time against the lethal issue. Stabilization has been observed over a number of years, constituting the initial clue of effectiveness noticed more than ten years ago.

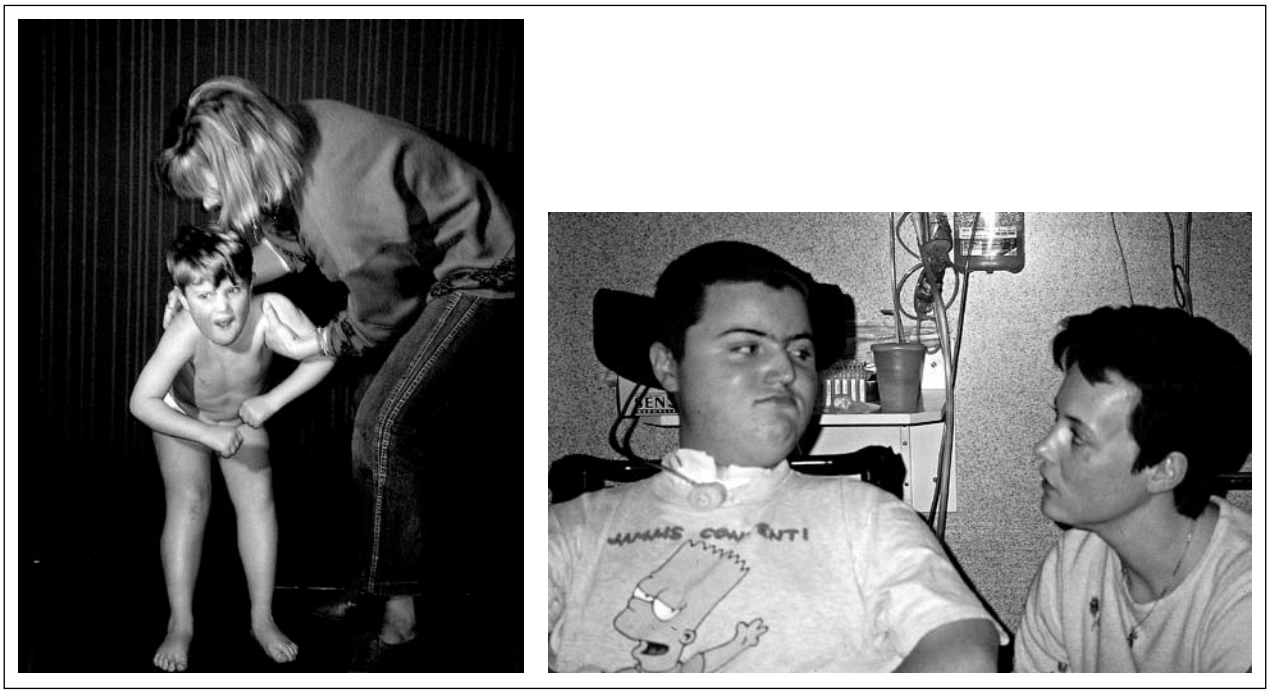


Figure 3. Another example of tracheal respiratory assistance in a child also suffering from a very severe DMD, even though all the recommended orthopaedic and therapeutic measures were carried out in a timely manner (stop of walking at 7 years, 9 months [on the left]; progressive respiratory deficit already observed at the age of 5 years, justifying early indication of nasal ventilation at the age of 9 years and tracheal ventilation imposed after a serious bronchopulmonary infection [on the right]).
Complementary publication concerned: Corrado A, Gorini M, De Paola E. *Alternative techniques for managing acute neuromuscular respiratory failure*. Semin Neurol 1995;15:84-7 (when an obstructive pulmonary infection occurs, with hypercapnia and hypoxemia, a more suitable mechanical ventilation is necessary, as well as oxygen supply and appropriate antibiotic therapy).
The desired global stabilization has already existed for ten years, thereby rendering possible a satisfactory quality of life. The evidence of a definite progress consists in the doubling of classical life duration.

in DMD gravity, nevertheless described as an "intermediate form" since the end of the 1970s, confirmed in a famous dystrophin study, published in the New England Journal of Medicine in 1988. These notions have direct influence on the comprehension for treatment to be respected and applied.

Why have I chosen the title "Requiem"? Not only for the successive involvements of physicians who have combated this emblematic disease of inexorability, but rather for the sake of the children and their families always set out in pursuit of more peaceful existence.

Seeing that basic research constantly ensures a proximate care, now if ever, is the time to enforce the life-saving objective of the waiting patients. In this connexion, one must assert that a rude mistake is being committed when specific caretaking principles are not respected (*Muscular Dystrophy, incurability, eugenics,* in Acta Myol 2007;XXVI:22-32). And now it is the interests of one and all that clinical medical progress already available may be improved and sustained by others.

Reference

Rideau Y, Politano L. *Research against incurability. Treatment of lethal neuromuscular diseases focused on Duchenne Muscular Dystrophy*. Acta Myologica 2004;23:163-78.

“Les funérailles que le matin annonce
résonnent dans celles du crépuscuple”
(Khalil Hani, Tonnerre blessé, Beyrouth, 1979)

“Le soleil ne tourne pas à l’envers, c’est le regard
qui doit apprendre à dépasser l’horizon”
(Monte Circeo, 1967-2007)

“The funerals that the morning announce
resound in the ones of the twilight”
(Khalil Hani, Tonnerre blessé, Beyrouth, 1979)

“The sun cannot change its tour,
it’s the eye that go beyond”
(Monte Circeo, 1967-2007)

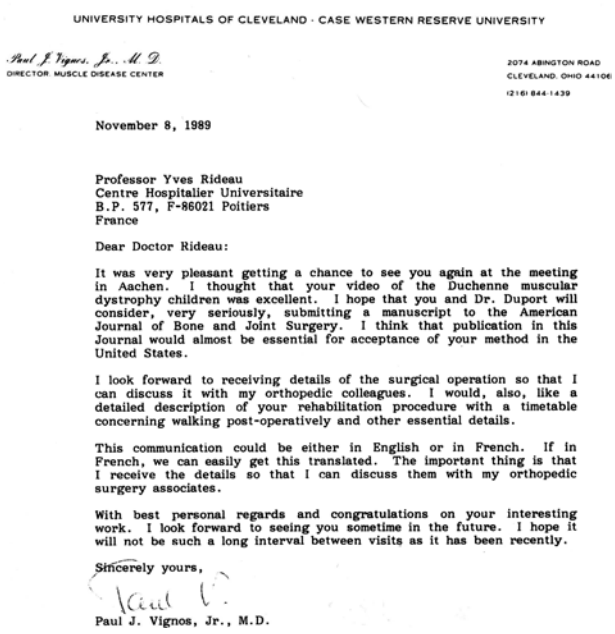
APPENDIX

The validation of the work just mentioned in "Requiem" was sometimes hampered by critical reactions, so that the diffusion of these advances remains incomplete. The assessments officially requested in France were never considered, though the results represent more than one hundred articles with recognition by several renowned peers. As the evidence of the usefulness of the treatment improving the quality of life of these patients exists, some positive comments, the most significant, deserve to be reported to conclude this presentation. They illustrate the lines of force implemented against the most critical complications of the disease. Already in 1872, Guillaume B. Duchenne, a noteworthy doctor, stated: "The prognosis is severe. In fact, when I was called to observe when the disease had reached the period of proliferation of interstitial connective tissue, I always assisted to a progressive generalized deterioration of the muscles, till a complete paralysis and death into the adolescence […] However, it appears that, in the final period, the subjects cannot long resist to intercurrent infections, which they usually die for". Our own struggle against complications falls partly as a continuation of this clinical founder research and responds to three complementary actions:

- First, protect the best childhood and lessen the shock of a destructive diagnosis.
- Then, protect the growth of the adolescent seated in wheelchair, trying to prevent deformations developing at this stage. In brief , the indications for these two stages involve an early surgery, before damage become permanent. This domain has been explored mainly with the firm assistance of Gerard Duport, Head of the Plastic Surgery Department, Poitiers.
- Finally, rule out the fatal prognosis that is accompanied by the frequent announcement: "there is nothing to do", as emphasized as a priority on many occasions. This objective led to the search for an original method of noninvasive ventilation, nasally performed. The real measure likely to meet this requirement was the use of a direct tracheal support, which induced a further search for the development of an improved interface, much more usable. The necessary technical adaptations have been carried out thanks to the availability of Andreas Hahn, ensuring the participation of the medical direction of a German company open to special requests. In addition, specific rules for late stage monitoring were specified thanks to the support of Italian physicians, first of them G. Fiorentino, in the group created with Prof. Giovanni Nigro in Naples.

Expert report on early treatment to preserve quality of locomotion in DMD

The therapeutic rationale statement concerns the correction of asymmetric musculo-tendinous contractures that would otherwise exacerbate muscle strength imbalance at the lower extremity joints, hasten lower extremity muscle weakness always perturb the quality of ambulation. The indication also derives from the decrease of the muscle strength (standard manual testing) and from the figures of the classic Gower's manoeuvre. The Vignos's letter below reported gives evidence of the interest regarding this approach in a consensus meeting.



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November 8, 1989

Professor Yves Rideau
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B.P. 577, F-86021 Poitiers
France

Dear Doctor Rideau:

It was very pleasant getting a chance to see you again at the meeting in Aachen. I thought that your video of the Duchenne muscular dystrophy children was excellent. I hope that you and Dr. Duport will consider, very seriously, submitting a manuscript to the American Journal of Bone and Joint Surgery. I think that publication in this Journal would almost be essential for acceptance of your method in the United States.

I look forward to receiving details of the surgical operation so that I can discuss it with my orthopedic colleagues. I would, also, like a detailed description of your rehabilitation procedure with a timetable concerning walking post-operatively and other essential details.

This communication could be either in English or in French. If in French, we can easily get this translated. The important thing is that I receive the details so that I can discuss them with my orthopedic surgery associates.

With best personal regards and congratulations on your interesting work. I look forward to seeing you sometime in the future. I hope it will not be such a long interval between visits as it has been recently.

Sincerely yours,

Paul J. Vignos, Jr., M.D.

So, it was agreed to prolong the period of normal living, and thereby improve the quality of life for every child with DMD. It is now clearly confirmed that this advantage can be achieved by a simple, well-tolerated approach with no risk to the patient other than that of general anesthesia. Normal living and quality of movements are prolonged at least 2 years without any other constraints.

The following parental perspective will serve also as a confirmation of this therapeutic effect applied at the onset of DMD: "In summary, we believe that [our son] has benefited in walking, balance, posture, and confidence, because of his treatment… I only hope that more boys get the chance to benefit from it" (1994).

The following two pages taken by the *Campbell's Operative Orthopaedic*, Mosby Year Book, 1991 confirm that this method was explained at an international level.

THE CAMPBELL CLINIC - DESOTO
INCORPORATED

7603 SOUTHCREST PKWY., SUITE 101 SOUTHAVEN, MS 38671 TELEPHONE (901) 577-9585

Service de Readaptation Medicale
et Reeducation Fonctionnelle
Pr Agr. Y. RIDEAU

September 24, 1990

Sage FP. Inheritable progressive neuromuscular diseases. St Louis : Mosby Year Book, Campbell's Operative Orthopaedics ; 1991. 4, p 2469-76. Complementary publication requested : Rideau Y, et al. Early Treatment to preserve quality of locomotion for children with DMD. Semin Neurol 1995 ;15 : 9-17.

Dear Dr. Rideau:

I sincerely appreciate your response to my letter.

It is urgent in order to include your technique in the next edition of Campbell's Operative Orthopaedics. I need to have the technique really as soon as possible.

I have really completed all of the revisions of the chapter on neuromuscular diseases and have turned it in to the publisher but if I can get your technique before we have the galley pages sent out to us, I could certainly include it.

I am anxious to do this, to include your material, because really this is one of the only recent innovations in the treatment of muscular dystrophy surgically that we have, so if you could get that to me expeditiously I would certainly appreciate it.

Sincerely yours,

Fred P. Sage, M. D.

CAMPELL'S OPERATIVE ORTHOPAEDICS. MOSBY YEAR BOOK. 8th Edit, Vol. 4, 1991.

«In 1986, Rideau, Duport, and Delaubier in France reported the results of early surgery performed on 10 boys with Duchenne's muscular dystrophy.

In 1990, Rideau reviewed 30 such patients who were treated between 1983 and 1987. Their average age at surgery was 5 years and 8 months, and the average age at follow-up was 10 years and 2 months. Each patient 3 months after surgery had recovered satisfactory functional ability without any serious complications. For treated patients, the period of nearly normal life was prolonged 30% on the average. During this time the quality of life was improved, being free of the constraints of conventional management, such as muscle exercises, passive stretching of contractures, and night splints; schooling also was more readily accessible. It is Rideau's opinion that these are the first recorded patients in whom the certain progression of the disease has been temporarily halted.

The patients must be carefully evaluated before surgery and any deformity, no matter how slight, should be noted and corrected. This is particularly true in asymmetrical deformities. Hip abduction contractures are evaluated with the child supine (to effect hip extension) and the legs dangling over the end of the table. An inability to bring the knees to the midline in this supine position indicates an abduction contracture of the hip (Fig. 48-11). This must be treated early, usually at about 5 years of age when an average Gowers' time takes less than 5 seconds.

■ ***TECHNIQUE (RIDEAU)*** (Fig. 48-12). The procedure is done bilaterally with the patient supine. Make an incision 2 cm inferior and posterior to the anterosuperior iliac spine and extend it to the anterior part of the thigh, parallel to the inguinal ligament. Identify the lateral femoral cutaneous nerve and protect

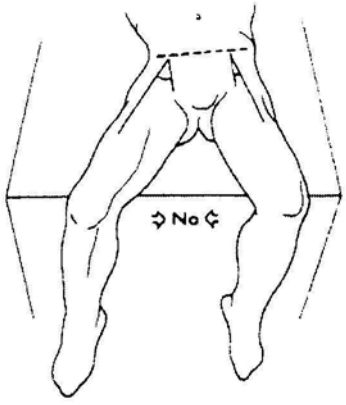

Fig. 48-11 Rideau technique of measurement of hip abduction contracture (see text). (Courtesy Dr. Y Rideau, Duchenne de Boulogne Unit, University Hospital Center, BP 557, 86021 - Poitiers, France.)

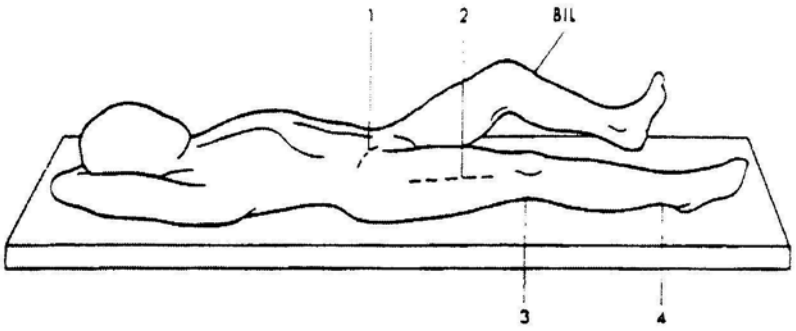

Fig. 48-12 Location of contracture releases (Rideau) (see text). *1*, Hip; *2*, lateral thigh; *3*, knee flexors; *4*, tendo calcaneus. *BIL* = bilateral. (Courtesy Dr. Y Rideau, Duchenne de Boulogne Unit, University Hospital Center, BP 557, 86021 - Poitiers, France.)

it. Open the fascia of the underlying muscles from anterior to posterior, and as the hip is abducted this tenses the gluteal muscles whose fascia is being cut. Divide the fleshy origins of the sartorius and tensor fasciae latae 2 to 3 cm distal to the anterosuperior iliac spine. Also release the tight anterior fibers of the gluteus medius and minimus if they are contracted. Sever the origins of the rectus femoris as well 1 to 2 cm distal to the anterosuperior iliac spine. Close the wound over suction drainage.

Next, make an incision over the lateral thigh 2 cm anterior and parallel to the prominence of the iliotibial tract, extending from the greater trochanter to the lateral femoral condyle. Incise the quadriceps fascia and develop the plane between the vastus lateralis and the iliotibial band. Incise the lateral intermuscular septum. Dissect the iliotibial band and the lateral intermuscular septum from the other tissues and remove them entirely from the entire length of the incision. Suture the remaining distal part of the tensor fasciae femoris proximally to the lateral aspect of the greater trochanter. Expose the biceps femoris in the distal end of the incision and, after protecting the peroneal nerve, lengthen the biceps femoris by a sliding technique if this tendon is contracted. Close the wound over suction drainage.

If there are other knee flexion contractures, a percutaneous tenotomy of the gracilis and semitendinosus should be done immediately. If full knee extension is still not possible, do an open lengthening of the semimembranosus.

Lengthen the tendo calcaneus percutaneously with two incisions over the lateral side of the tendon 5 to 6 cm apart and forcefully dorsiflex the foot.

AFTERTREATMENT. No activity is undertaken for the first 3 to 4 days after the operation. The ankle is maintained in the correct position of dorsiflexion by a light splint held by an elastic wrap. On the fourth or fifth day, once incisional soreness has subsided, ambulation is begun. During the 2 weeks required for wound healing, continuous attempts at functional activity should be made. Home physicial therapy should be continued for 2 months after the operation, at which time it is no longer indispensible. An upright posture (Fig. 48-13) can be anticipated postoperatively and a delay in the average age when it is impossible to arise from the floor is extended by about 2 years.

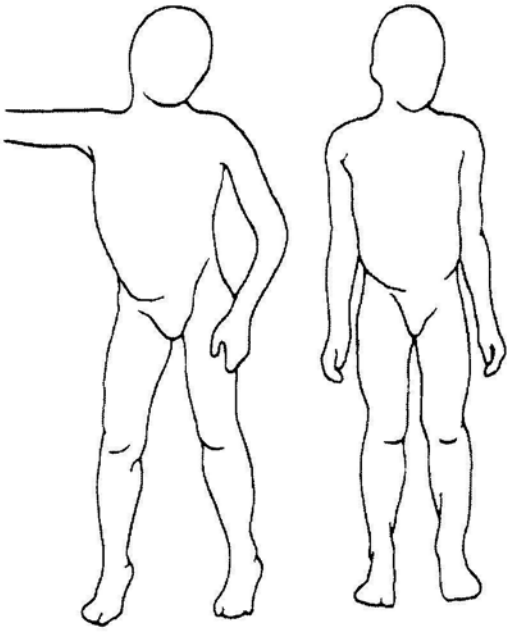

Fig. 48-13 Upright posture at age 9 years. *Left*, untreated patient. *Right*, treated patient. (Courtesy Dr. Y Rideau, Duchenne de Boulogne Unit, University Hospital Center, BP 557, 86021 - Poitiers, France.)

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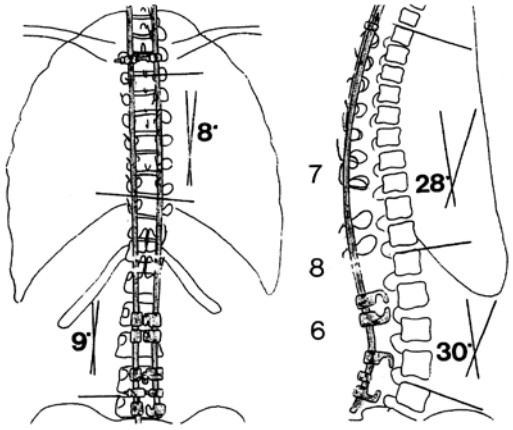
The above improvements cited by Rideau were temporary, but a life-style without the use of orthoses was extended. Ultimately, a rapid and progressive increase in difficulty getting up from the floor and loss of ambulation occurred within a few months. With this protocol, in the early stages of the disease, between 4 and 6 years of age, the life-style of these children was certainly better.

In general, in the United States, correct timing of the surgical procedures depends on the patient's ability to walk without falling. Surgery should be performed just before the child would refuse to walk. This is usually determined by the number of falls a child sustains each day. When weakness and contractures become such that the patient is so unstable that he falls three or four times a day, he is soon going to sit down and not try to walk.

Patent in vertebral instrumentation for surgical scoliosis in DMD

It is an obvious critical point to prevent severe and disabling trunk deformities. On our experience thoracolumbar bracing and spinal supports never prevent the progression of scoliosis in DMD, while the conservative approach, using orthotic aids, has not produced proofs in this particular disease. On the other hand, if surgery of the spinal deformities is delayed – as classically ruled – until 30 degrees of scoliosis, the decrease of pulmonary volumes might contraindicate the use of general anaesthesia, and therefore preclude the treatment. Thus, essentially an early surgery (Fig. 4) is the only means to prevent serious spinal deformities for a majority of patients (Duport G, Gayet E, Pries P, et al.: *Spinal deformities and wheelchair seating in DMD: twenty years of research and clinical experience*. Semin Neurol 1995;15:29-37).

Finally, early spinal fixation had promoted a specially adapted instrumentation, designed to satisfy the specific technical and mechanical concerns, which are basically different from those of idiopathic scoliosis. The objective was to preserve the physiologic spinal curves without pejorative effect on respiratory function and an useful degree of spinal flexibility while permitting growth of the trunk and long-lasting correct seating position. We systematically recommend the use of special instrumentation, steel-wired at multiple attachments to the dorsal transverse processes, at the level of the dorsal smooth part of the rod. We believe that it minimize significantly operative risks.



VERTEBRAL INSTRUMENTATION ROD

United States Patent

Patent Number: 5,593,408
Date of Patent: Jan. 14, 1997

This rod is made up of a first cylindrical part, being a lumbosacral part (6), which is rigid in all directions, a second part, being a dorsal part (7), which is rigid in a frontal plane, in order to prevent scoliosis, and flexible in a sagittal plane, and a dorsolumbar transition zone (8) connecting the lumbar and dorsal parts and profiled in a progressive manner so that its thickness in the sagittal plane diminishes progressively and its width in the frontal plane increases progressively: this profile is such that the second moment of area of the transition zone reins substantially constant over its entire length. The profile, thus defined, of the transition zone has the aim of avoiding, to a great extent, the risks of breaking due to the fatigue in this zone, resulting from the various movements of the patient in a chair, in particular the flexion/extension movements in a sagittal plane, promoted by the rectangular profile of the dorsal part of the rod.

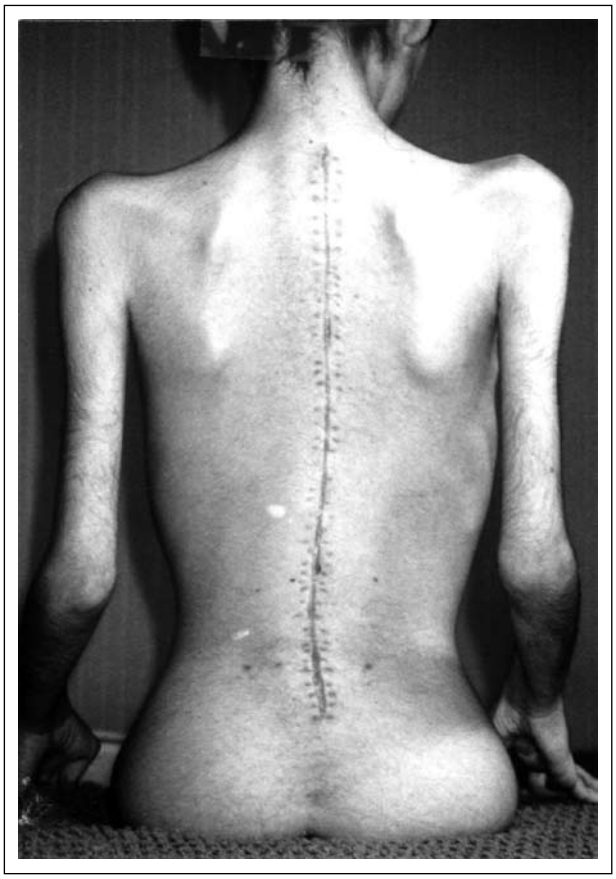


Figure 4. A protected spine without other body constraints.

Most of the strategies against fatal issue in DMD

It should be emphasized that giving a final conclusion in a research project concerning the issue of the evolution of a chronic illness needs many time. Under these conditions, it is unrealistic to call on traditional comparisons between a "treated group" and a "control group" without treatment. In practice, accurate references of the natural history of the disease should be established and published widely, which was our first action at the start. Thus, a limited number of cases, or even a single individual case when necessary, can be compared with the natural history figures. This procedure is particularly useful to continuously monitor the effectiveness of an open, not pharmacological, therapeutic approach. That is why the conclusion of our clinical research deserves to call the observation of an exemplary case, the first child who received the full symptomatic treatment of Poitiers, closely supervised throughout 25 years by specialists from different countries (Case RF - dob 11/10/1980 - formal diagnosis of DMD established at the age of 3 years 11 months; CK: 13,608 IU; EMG and muscle biopsy consistent with the clinical diagnosis, confirmed at 14 years by total absence of dystrophin and presence of a mutation in the corresponding gene) (Fig. 5).

The validation of such a model requires to exceed the laboratory tests, thanks to a certification of the clinical course evaluated through the pattern of his individual muscle weakness, to be compared with pre-established reference values.

The precise identification of the disease was clearly analyzed (Fig. 6). This was temporarily modified at the beginning of the disease, after a first surgical procedure performed at the age of 5 years 3 months (1), who provided a temporary stable life, without medical problems, until the age of 9 years (Gowers's manoeuvre impossible at the age of 9.9 years). Then, the evolution has resumed with a force annual loss of -6.4% overlapping precisely that of the control group, quantified in -6%. At the age of 14 years 3 months, a specific treatment of the spine was also required (2). Once for all, at the end of adolescence, the functional motor capacity becomes minimal, signing the evident conformity with a classic diagnosis of DMD (Fig. 6).

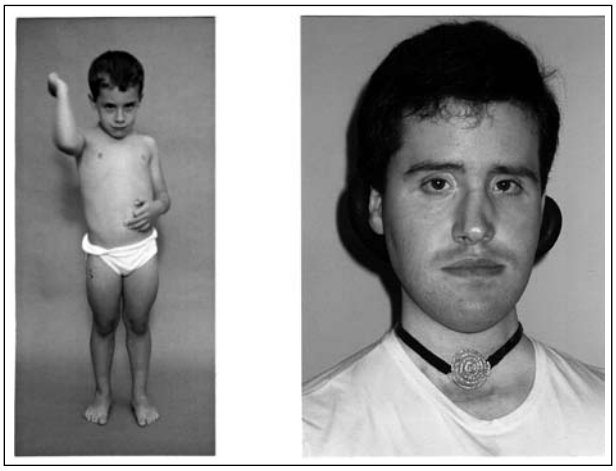


Figure 5. Case RF. Appearance at the age of 4years 9 months, at the beginning of his disease (on the left), and at the end of the third decade of his life (on the right).

Besides experienced testing of muscle deficit, requiring the confidence of the sick child, the most objec-

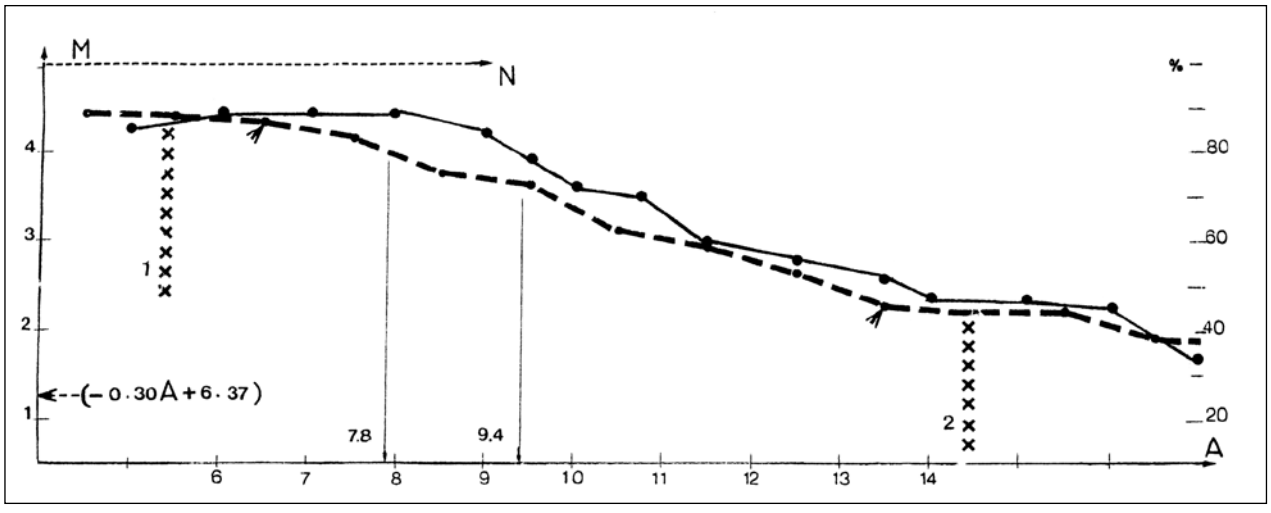


Figure 6. Case RF. Diagram of the course of the muscle weakness according to age observed for an individual case (solid curve), compared with classic reference values (doted curve, established on 240 untreated cases).

tive criterion – as we always recommend – must be the follow-up of respiratory function measured by the values of vital capacity (VC). All our therapeutic research has focused on quantifying the decreasing phase of this parameter, characteristic in DMD, with the aim of controlling the possibility of changing the gradient. It is in these conditions that the concept of early nasal ventilation was designed, in 1980, in order to achieve the goal of reducing the VC damage (Fig. 7).

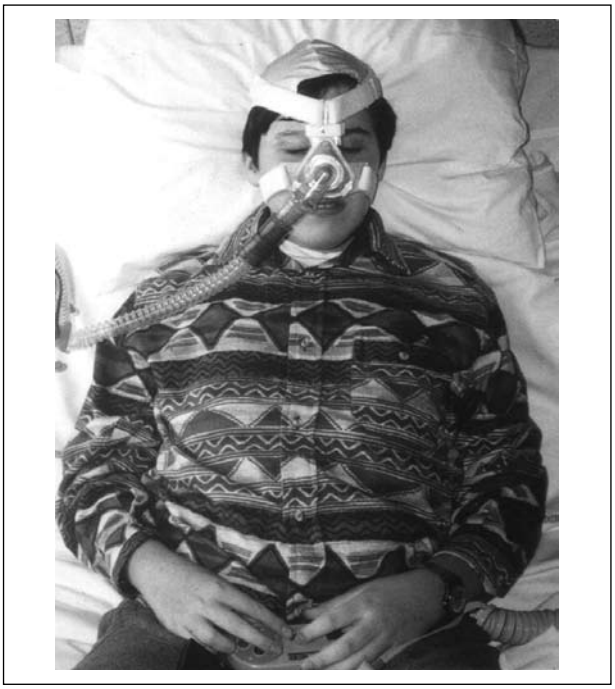


Figure 7. Case RF. Early indication of custom-molded nasal interface, assigning several devices in order to obtain the most efficient long-term tolerance.

The plot of the steady decline in the CV of our patient consents to demonstrate (Fig. 8):

- an early negative slope from the age of 8 years, indicating the likelihood of a fatal exit before 18 years of age (the loss of VC was -7.21% per year for this case, near -8.06% of the control group);
- a very early attempt to perform nocturnal ventilation at the age of 10 years 6 months, regularly continued for 13 years (changes in vital capacity show a positive effect of this measure, mainly for two significant periods, at ages 10 to 14 years and 15 to 17 years. This improvement had as a consequence a prolongation of his life expectancy of 5 years, that means a positive result, but too partial on the long-term: the loss of VC was -2.98% per year over the whole period);
- a final recourse to a direct intra-tracheal support through a common desire to play down the tracheotomy image with pejorative intubation (research on a concept of "tracheal nostril"). An agreement for the use of a minimally invasive interface prototype (OstRing) was understood and concluded according to our strict rules of surveillance.

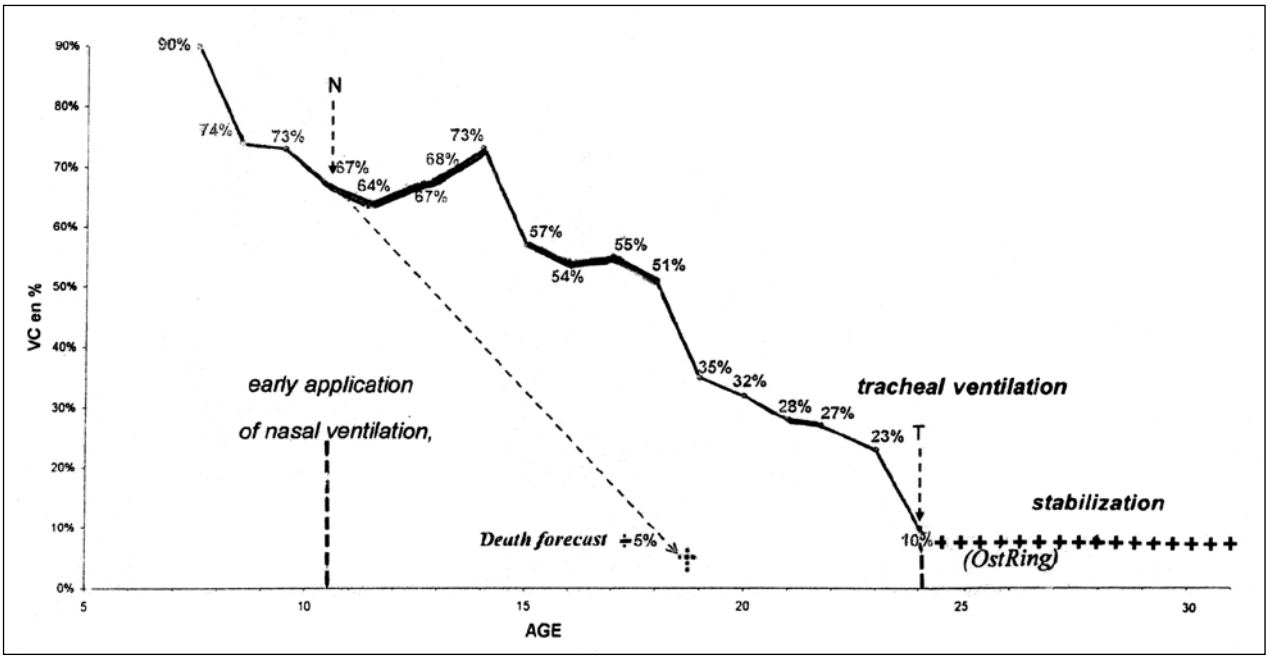


Figure 8. Case RF. Diagram of the course of chronic restrictive syndrome (CV%), according to age and to various therapeutic trials in order to stabilize the lethal deficit.

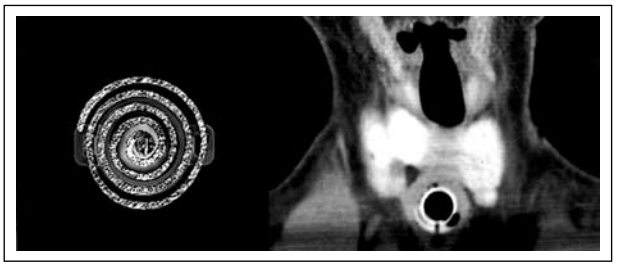


Figure 9a. Principle of "tracheal nostril", corresponding to an orifice (*Ostium*) of the trachea, carefully performed, easily concealed on request.

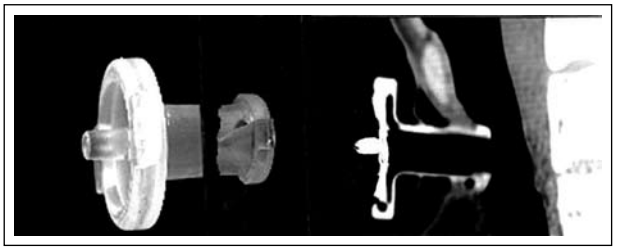


Figure 9b. Positioning of a lining device (Ring) in this *ostium*, able to be open or closed according to the ventilator use or the period of autonomy to be achieved.

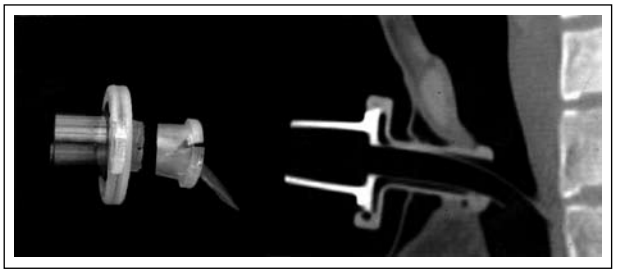


Figure 9c. Insertion into the ring of a endo-tracheal tube, the least invasive possible: the control of the impact of a foreign body in trachea uses imaging techniques and endoscopy to screen unwanted pressure zones; this examination has to be performed regularly for practical controls.

Therefore, the motive of this final step of our work, a tracheal access in a very fair condition, has been reached. The management, at this stage, normally requires a very careful supervision, schematised by two illustrations: the concept of an original interface, the OstRing (Fig. 9) and the usual necessary cares for this ventilary access (Fig. 10).

In conclusion, a full stabilization has been obtained for 7 years until now, allowing living conditions rather exceptional, raised by his family in May 2009: "The result can be described as valuable and indisputable. For almost five years, the lung function has remained stable and, especially, the frequency of aspirations became almost zero (once a week to once a month), while the daily autonomy – without assistance – is preserved for 7 hours/24 on average. R. lives happily with us and his sister. It will discuss his PhD thesis at the University next October" (Fig. 11).

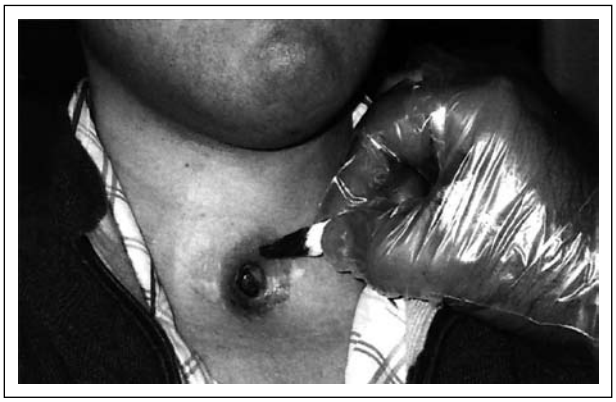


Figure 10a. Traditional hygienic care at the *ostium* level.

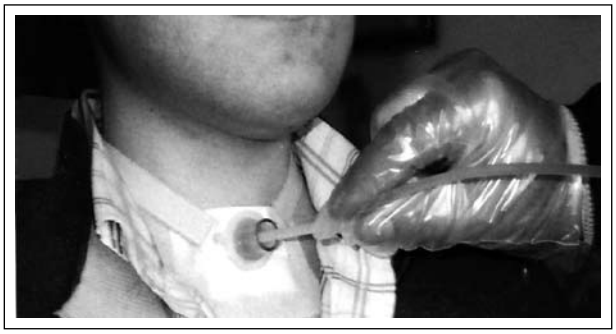


Figure 10b. Regular counting of the number of aspirations of the secretions in the respiratory tract. If they become too frequent, bacteriological analyses and prophylactic antibiotics are indicated (the most frequent infections are caused by *Staphylococcus aureus*, *Serratia* or *Pseudomonas*).

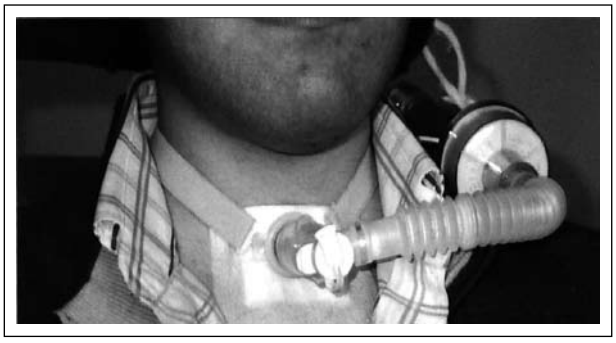


Figure 10c. Assisted ventilation by positive pressure, according to ordinary standards, with routine monitoring, to protect the intermittent utilization of the ventilator apparatus and preserve the daily autonomy.

Figure 11. A doctoral thesis on the "Assistance for the disabled people at the Europe Universities", presented by a DMD student humanly normal, was honored by the maximum score of 110/110.

Medical priority for life followed in this case highlights an obvious logic. The protection of breathing should not be introduced at the end of a lethal evolution, in a critical condition, but at the beginning of the observation of the respiratory deficit, symptomatic of DMD.

If the future is directed towards improvement of a non-traumatic tracheal device, early indications should be normally considered to treat, as a first intent, the most serious cases of neuromuscular diseases. As it has been the case with the generalization of our nasal ventilation techniques, future improvements in this new field could be also useful for many other patients.