Hypospadias dilemmas: A round table

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Received 19 November 2010; accepted 20 November 2010

KEYWORDS
Hypospadias

Introduction

At each step in the assessment and management of hypospadias arise questions and dilemmas that the four authors of this round table would like to list and explain from their point of view. From evaluation of hypospadias severity, preoperative biological assessment, preoperative hormonal stimulation, choice of urethroplasty to the postoperative evaluation, many divergences exist. Yet there is need to find a consensual approach to this congenital anomaly in pediatric urological practice. Warren Snodgrass, Antonio Macedo and Pierre Mouriquand developed this dialogue following their panel discussion at the World Congress of Pediatric Urology. Piet Hoebeke was asked to referee their comments to highlight areas of agreement and dispute.

Anatomy and classification

Question 1: What criteria do you find relevant to evaluate the severity of hypospadias?

PM: Severity follows the anatomy of hypospadias, which could be defined as a development halt that leads to an insufficient development of the genital tubercle essentially marked by a ventral triangular defect [1]. Its summit is formed by the proximal division of the corpus spongiosum, the lateral sides by the two atretic pillars of spongiosum, and the base by the widely open glans. The more proximally the spongiosum divides, the more severe the hypospadias is. The position of the urethral meatus does not seem to be a solid enough parameter to define this severity as, quite often, the urethra sitting proximal to the ectopic meatus is poorly developed and may need to be refashioned. All tissues sitting inside this triangle are under-developed, hypoplastic or dysplastic, although there is no histological consensus to define these concepts. As well as the level of division of the spongiosum, the size of the glans is a relevant criterion, the

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smaller ones being more difficult to repair. Finally, the quality of the urethral plate is essential to select the most appropriate technique for urethroplasty.

AM: The severity of hypospadias cannot be solely based on the meatal location assessed at the first consultation. The size of the penis (especially the glans), the amount of dorsal foreskin, glans morphology, associated scrotal abnormalities (penoscrotal transposition), and age at initial presentation are additional indicators of severity to be defined for primary repair. The operative technique can only be decided in the operating room. Parents should be informed of the main techniques and follow up commonly used by the surgeon. Assessment of the urethral plate and the penile curvature (erection test) are the main indicators of severity, since preservation or section of the urethral plate is an essential step in the selection of the reconstructive technique.

WS: The spectrum of hypospadias varies from glanular forms, which may require no intervention, to perineal openings with ventral curvature greater than 90 degrees that may need two planned stages to correct, with additional procedures for resulting complications. Where along this continuum should the term ‘severe’ apply?

Consider two boys with penoscrotal hypospadias, one having no ventral curvature and a urethral plate that is readily tubularized for one-stage repair, versus another with ventral curvature that persists despite all known maneuvers to straighten the penis, resulting in plate transaction and a tubularized flap or staged graft repair. Clearly the second has a more ‘severe’ hypospadias than the first, yet both have more ‘severe’ defects than other boys with subcoronal hypospadias, and less ‘severe’ conditions than those with perineal hypospadias.

For optimal clarity in scientific reporting, so that authors and readers can be certain they are discussing similar patients, subjective terms such as ‘severe’ should be avoided.

PH: There is consensus here that severity can only be judged during surgery and that observations during dissection will help in taking the final decision on the technique to be used. All three experts judge severity based on position of the meatus, quality of the urethra and the urethral plate, and presence or absence of curvature. Efforts should be made to come up with a unique severity score based on these observations. This would allow comparison of outcomes among different surgeons.

WS: I disagree with the statement regarding urethral plate ‘quality’, as subjective assessments which inevitably differ from surgeon to surgeon open a whole Pandora’s box of confusion that then hinders scientific communication.

PM: No, I don’t think that the position of the urethral meatus is a reliable parameter to classify hypospadias, as the anatomical anomaly starts much more proximal, where the corpus spongiosum divides.

Question 2: When and how do you evaluate the severity of hypospadias?

PM: The most reliable way to assess the severity of hypospadias is in the operating room once the ventral and lateral aspects of the penis have been fully exposed and the penis fully degloved. It is then possible to identify the level of division of the corpus spongiosum, the quality of the urethral plate, the size of the glans and the degree of hypoplasia of the ventral tissues.

AM: This issue might be one of the few where we all agree.

WS: Evaluation is done both pre- and intra-operatively. The vast majority of patients have glanular/coronal, subcoronal or distal shaft hypospadias, and will undergo repair with the expectation of success after a single procedure. The only preoperative decision is whether the family prefers circumcision or prepuciotomy.

A minority have proximal shaft to perineal hypospadias with varying degrees of ventral curvature, the true extent of which cannot be accurately determined preoperatively. Still fewer have a distal meatus with obviously thin skin covering a portion of the more proximal urethra, which will require treatment similar to others with a penoscrotal meatus. Sometimes, there is a short urethral plate and penoscrotal meatus that will prove to be either a distal shaft meatus with scrotal encroachment on the penile shaft, or a penoscrotal meatus with ventral curvature greater than 90 degrees. All these patients also have the option of circumcision or prepuccioplasty, but preoperatively I additionally measure glans width at the mid (widest) point to determine whether to recommend preoperative testosterone stimulation.

Intraoperatively all patients undergo a similar approach, preserving the urethral plate for TIP (tubularized incised plate) repair unless transaction is required for straightening ventral curvature.

PH: From Question 1, consensus is to be expected and the conclusion is that severity will be judged during surgery.

Question 3: How would you classify hypospadias?

PM: Following the anatomical description given above, I would distinguish [1]: 1) hypospadias with a distal division of the corpus spongiosum with little or no ventral curvature; 2) hypospadias with a proximal division of the spongiosum with a marked ventral curvature related to the poor development of the ventral tissues sitting in the triangle described above, and sometimes related to an asymmetrical development of the corpora cavernosa; 3) hypospadias cripple who already underwent several procedures leaving behind scarred tissues.

AM: I believe that hypospadias classification is better related to the difficulty of reconstruction. In this respect, the aspect of the urethral plate and the need for dividing it are the two main factors to categorize a hypospadias. I would therefore distinguish hypospadias with a preserveable urethral plate (most distal and midshaft hypospadias and some proximal ones) from those that need division of the urethral plate and therefore a more extensive reconstruction. Hypospadias cripple should be individualized as a third group.

WS: Hypospadias should be described as primary versus reoperative. Within both groups, meatal location at the time of urethroplasty most likely is the best means for consistent, reproducible, classification. How else can we agree on the extent of hypospadias in the patient that preoperatively has a penoscrotal opening that is revealed to be only a distal shaft
defect when the scrotum is dissected from the penile shaft? If we instead use the point of divergence of the corpus spongiosum for classification, how do we then distinguish between two boys with a distal shaft meatus whose lateral wings of spongiosum converge at the same proximal location, one of whom has such deficient subepithelial tissues that it is impossible to separate shaft skin from the urethra, requiring a proximal hypospadias repair, while in the other the skin is easily dissected from the urethra for a straightforward distal shaft repair?

The idea that proximal divergence of the corpus spongiosum indicates 'severity' of hypospadias may be traced to Duckett, who did not like the Mathieu repair and so would 'cut back' a subcoronal meatus to the convergence of the spongiosum so that an onlay flap would fit.

Accordingly, authors should continue current meatal descriptions: glanular/coronal, subcoronal, distal shaft, midshaft, proximal shaft, scrotal and perineal, since readers can readily, and accurately, visualize the defect being described. Methods should clearly define sequential steps used for straightening ventral curvature, and also when, why, and how often a distal defect was 'cut back' to create a more proximal defect. Those undergoing primary repair should be clearly distinguished from reoperations.

PH: It is clear that classification is not a standardized issue. There is consensus that reoperative hypospadias is a separate group; however, for the primary repair there is no consensus. From the answers to Questions 1 and 2, I would have expected that most experts would try to classify along the lines of severity. An objective severity classification would probably be the solution to resolve the disagreement evident in the answers to this question.

Etiology

Question 4: If, when and how do you request a preoperative biological screening of your hypospadiac patient?

PM: No one knows the answer. Many would evaluate the biology when the hypospadias is considered as severe or associated with other anomalies. As our department belongs to the national reference centre for DSD (disorders of sex development), we decided to evaluate all patients with hypospadias in order to identify whether underlying biological impairments are more common in one category or the other. So far we can’t say but more cases are needed. Until we get more data, we cannot formulate recommendations.

Regarding the nature of this biological assessment, four main targets [2] are potentially interesting: 1) the child himself with his genes and chromosomes, his hormonal production (gonads) and central control, his target tissues with their hormonal receptors and protein platform; 2) the placenta, which is probably the essential actor of the fetal hormonal machinery during the first part of gestation; 3) the mother who acts as the reference system; and 4) her environment during gestation (hormonal disrupters and promoters). Three periods are informative and require different tests: 1) day 1; 2) the mini-puberty (day 15 to day 90–120); 3) after day 90–120 until puberty. During the first two periods, testosterone and its precursors can be measured in the child’s blood and reflect the potential Leydig cell activity. After 90–120 days of life, testosterone levels are no longer detectable until puberty. The anti-mullerian hormone (AMH, produced by the Sertoli cell) can, on the other hand, be measured throughout childhood and will drop once puberty starts. Some [3] believe that most hypospadias are the consequence of faulty functioning of the gonads (gonadal dysgenesis), and advise measuring both Leydig (testosterone and precursors) and Sertoli (AMH, inhibin B) activities. Beyond 120 days of life, the only way to evaluate Leydig cell function is to perform a HCG (human chorionic gonadotropin) test, the modality of which is extremely variable from one center to another. The use of recombinant HCG is not yet validated in children in France.

AM: Preoperative assessment has very little impact on the management of a child with hypospadias or on his family, unless clear environmental factors affecting the development of the genital tubercle are identified. External hormonal agents as those used in ICSI (intracytoplasmic sperm injection) and in-vitro fertilization cannot be avoided. Associated genital anomalies, such as undescended testes, micropenis and urogenital sinus, might require further endocrine and genetic tests.

WS: Most cases of hypospadias appear to be isolated defects, while a few occur within syndromes. The latter patients usually have already had karyotyping before referral. Genetic factors, endocrinopathies, and gene mutations have all been described, but are uncommonly detected in nonsyndromic hypospadias. Insights into the etiology of hypospadias may be gained by chromosome microarray analysis in the future, but presently, in the absence of a research protocol, the only patients who we consider for preoperative assessment are those with hypospadias and undescended testis to detect DSD.

PH: The answer to this question is determined by the setting where a surgeon is working. Working in a strong academic environment with a multidisciplinary DSD team, the tendency to perform multiple testing is prevalent, and can be understood as being driven by the lack of knowledge about the pathophysiology and embryogenesis of hypospadias. For those who are not in such a center, the statement that the treatment and the outcome are independent from possible underlying mechanisms is absolutely correct: it will not change a lot for the patients. Despite this, academic curiosity should further drive research into this matter, as it will be helpful to understand more complex forms of DSD where hypospadias is often present.

Question 5: Which forms of hypospadias should undergo multidisciplinary assessment with an endocrinologist, a geneticist, a biologist, a psychologist, and a surgeon?

PM: Here, the answer could be the same as for the biological assessment. We don’t know, but most centers will provide a multidisciplinary approach for the 'severe' hypospadias or hypospadias associated with other anomalies.

AM: Those patients are described above. I do not believe that scrotal or even perineal hypospadias with palpable testis in the scrotum should undergo further investigation at initial diagnosis. Since we are treating these patients mostly at 6–9 months of age, the intervention of psychologists and psychiatrists is not necessary.
WS: We do not currently recommend a multidisciplinary evaluation, although endocrinologists sometimes assist with evaluation of those few patients thought to have DSD.

PH: Consensus here that those patients who are suspected to have DSD (because of associated genital anomalies, most often nonscrotal gonad) should be evaluated.

Question 6: Do you consider that all hypospadias cases are DSD? If not, which ones would you classify in this group?

PM: Yes, I do. Although the term DSD may be confusing, all DGD (disorders of genital development) reflect a mal-development, which reflects a faulty process even if the nature of it is most of the time unknown. Unless some centers screen all hypospadias patients, no one will know what we are talking about. We are clearly over-investigating these patients in order to identify those who really need to be investigated. It is not even certain that endocrinology, i.e. hormones, plays a major role in these anomalies.

AM: If you are following a protocol, full investigations are acceptable; if not, I would follow the indications I gave in my answer to Question 4.

WS: By definition, neither hypospadias nor undescended testes is considered a disorder of sexual development, even though they may represent part of the spectrum that includes 46XY DSD, and occasional patients with the combination of hypospadias and undescended testis have ovotesticular DSD or mixed gonadal dysgenesis. Ultimately, all classifications of biologic systems are somewhat arbitrary, yet necessary for scientific communication.

PH: I like the idea of grouping within DSD all DGD, and trying to find out if underlying mechanisms are apparent. From the comments, the general idea is that what you call it will not change treatment or outcome.

From these first six questions, it is clear that severity of hypospadias is an issue that determines treatment and outcome, while pathophysiology and embryogenesis generate rather an academic discussion with no consensus between different experts.

As hypospadiologists, we should try to get consensus on a standardized severity classification system that would allow us to compare our outcomes.

PM: There is a major misunderstanding over the definition of DSD [4]. DSD do not equal intersex. In the latest issue of the Journal of Pediatric Urology [5], Hughes points out this confusion.

Simple hypospadias although not ‘intersex’ is a disorder of sex development, like any anomaly of the genital area, even minor labial fusion. It is likely that the concept of DGD would be easier to grasp for surgeons.

Preoperative hormonal stimulation

Question 7: If, when and how would you stimulate the hypospadiac penis prior to surgery?

PM: I would consider androgen stimulation when the genital tubercle is under 25 mm long during the first year of life or if the glans is small (diameter <15 mm) [6,7]. I would definitely leave a 6-month gap between androgen stimulation and surgery to avoid the potential detrimental effects of androgens on the healing process. Our group is currently evaluating preoperative topical estrogen stimulation in order to boost the healing process in patients with proximal division of the corpus spongiosum.

AM: I have been treating children of less than 1 year of age with 30–40 days of preoperative 1% testosterone cream once a day (1 finger unit). Recently, several papers reported the increased vascularization of the penis after androgen stimulation, with a better size and a better delineated urethral plate. I have some concerns about the deleterious effects of androgens on the wound healing process. I tend to limit androgen stimulation to the very small sized penis.

WS: There is only objective data that preoperative stimulation increases penile size and glans circumference, with the caveat that these gains frequently regress within 3–12 months. There are no data that preoperative stimulation either improves or worsens surgical outcomes. From my prospective databases, it is clear that glans dehiscence occurs statistically more often in proximal than distal repairs, despite the same surgeon using the same technique with the same sutures for glansplasty. The separate observation that the penis and glans are sometimes smaller in proximal cases suggests glans size might be a modifiable factor to decrease this complication. In the past, I used hormones when the glans appeared, subjectively, small, and to date no published data include normal glans width or circumference. Presently, I am measuring glans width in all patients with proximal hypospadias, and recommending preoperative testosterone injections (2 mm/kg/dose for three injections done at intervals of 3–4 weeks) when the glans is <14 mm.

PH: Some consensus but based on no evidence. The consensus seems to be that a small glans will be the motive to use preoperative stimulation. Just an observation on the low level of evidence for hormonal treatment, while this is one of the issues in hypospadiology that could easily be studied in a randomized placebo-controlled design. Time for such a prospective study.

WS: You are correct, but this would require a multi-institutional study to accomplish, given the large numbers of patients needed to achieve sufficient power. My data indicate a 13% glans dehiscence rate for proximal hypospadias. Preoperative hormonal therapy might decrease that to the 2–4% range of distal hypospadias. A randomized controlled trial would have to involve several hundred patients with proximal hypospadias all operated by similar means for glansplasty to potentially show this difference; and with most centers dealing with 25 cases of proximal hypospadias per year at most, the logistics are not encouraging. We have given a lot of thought to such studies, but this whole dialogue points out that we have a long way to go in defining severity and agreeing on surgical management before we can design studies that isolate single variables in outcomes.

Surgical repair

Question 8: If, when and how do you assess the penile curvature?

PM: I have to confess that in most hypospadias cases with anterior division of the corpus spongiosum I do not...
perform an erection test, as I know, by experience, that most cases of ventral curvature are corrected by dissecting the ventral aspect of the penis. I still perform the erection test in the most severe hypospadias with a proximal or perineal division of the spongiosum.

AM: I perform an erection test after completely degloving the penis and after assessment of the urethral plate. I place the tourniquet under the foreskin. I used to puncture the corpora through the glans. Nowadays, I perform a direct puncture of the corpus cavernosum in a non-vascularized area. Obviously, distal hypospadias can be evaluated by finger compression of the penoscrotal junction without saline infusion.

WS: In proximal hypospadias, I first complete degloving (for patients to have circumcision) or ventral release of the shaft skin (for patients to have prepubicoplasty), ventral dissection of dartos, and release of the separated wings of the corpus spongiosum from both the underlying corpora cavernosa and their fusion with the glans wings, before artificial erection. If curvature >30 degrees persists, then dissection continues under the urethral plate to completely elevate it from the corpora cavernosa. If there is still curvature >30 degrees, dissection then extends under the proximal normal urethra to near the membranous segment— all to take advantage of the natural elasticity of the urethra and urethral plate to allow penile straightening without transecting the plate. Ventral lengthening is achieved by three transverse incisions several millimeters apart from 4 to 8 o’clock just through the tunica albuginea of the corpora cavernosa in the area of bending, without subsequent grafting. If after all these steps the penis remains curved more than 30 degrees, then the plate is transected.

PH: Some consensus that in distal hypospadias curvature is not a problem and that in proximal hypospadias it should be part of the evaluation during surgery to judge severity and help to choose the ideal technique for repair. This approach can be considered standard in hypospadias repair.

Question 9: Do you think it possible that posterior hypospadias can have no curvature?

PM: No. All hypospadias cases with a proximal division of the corpus spongiosum have a ventral curvature that is directly related to the degree of hypoplasia of the ventral tissues, and possibly to asymmetrical corpora cavernosa. This does not mean that all posterior hypospadias require a corporeoplasty to straighten the penis, but some will do. Amazingly, in our experience of the Koyanagi—Hayashi procedure, as well as in the Necker experience, few of the most severe hypospadias cases corrected by this technique required a corporeoplasty.

AM: It depends on which step of surgery is being considered. At initial phase no, but after full dissection of the ventral aspect of the penis, many penises are straight. My approach is to first untether the urethral plate; if there is persistent minimal curvature (<20°degrees), I would perform a modified Baskin plication; and for major curvature, I would divide the urethral plate and if necessary associate a Baskin dorsal plication. Contrary to what most authors say, a corporeoplasty is rarely necessary. These are the cases of true corporal disproportion, and are well treated with either a tunica vaginalis flap or a dermal graft (older patients). If a corporeoplasty is indicated, I go for a two-stage repair. If after urethral plate section the penis is straight, I reconstruct the urethra with inlay buccal mucosa graft and go for a one-stage repair (the three-in-one technique).

WS: We have documented and published incidence of ventral curvature following this step-wise ventral dissection [1]; 50% of patients with proximal hypospadias have either no remaining curvature after degloving and dartos dissection, or curvature of less than 30 degrees readily straightened using a single midline dorsal plication with 6-0 prolene. The other 50% have curvature greater than 30 degrees, but with mobilization of the corpus spongiosum wings, the urethral plate and, as needed, the proximal normal urethra, combined with ventral corpora incisions described above, we are able to straighten the penis and preserve the urethral plate in half of these.

PH: The final answer to the question is that not all posterior hypospadias will need correction of curvature; about 50% can do without. For those who need correction it is clear that all possible techniques for corporeoplasty are used, and that there is absolutely no consensus on how to treat a curvature. Long-term follow-up studies (if possible prospective) are needed in order to select the best technique. From literature on Peyronie’s disease treatment, it is clear that plication is preferred to corporal grafting, which seems to have a deleterious effect on potency, an issue we should remember when treating patients who will become sexually active at the time when we retire from our jobs [1].

Question 10: What are the causes of ventral curvature?

PM: Most ventral curvatures are related to hypoplasia of the ventral tissues sitting beyond the division of the corpus spongiosum. The untethering of all ventral tissues after degloving the penis may solve a large number of curvatures. Those that persist are related to asymmetrical corpora cavernosa which require a dorsal plasty of some form (TAP (tunica albuginea placation) or Nesbit like procedure). I have no experience of ventral corporeoplasty. It is certainly the merit of Baskin’s work [8] to have shown that the dorsal midline is a safe territory to perform dorsal plasty.

AM: Most curvatures are due to the tethering of ventral tissues at skin level and below. Releasing these attachments and urethral plate division associated to dorsal plasty (Baskin) is the procedure used in most cases. When these maneuvers are not sufficient, a ventral corporeoplasty should be performed.

WS: If hypospadias results from arrested development when the forming penis is curved downwards, then persisting ventral curvature represents a shortening of ventral tissues: the shaft skin, dartos, spongiosum, urethral plate, and/or corpora cavernosa. For example, all hypospadiologists know that apparent curvature often corrects with degloving alone, noting that the ventral skin originally attached to a subcoronal meatus subsequently rests at the penoscrotal junction — indicating simple deficiency of ventral shaft skin.

Based on prospectively maintained data from a uniform protocol of step-wise correction of ventral curvature, it is clear approximately 50% of patients with proximal hypospadias have curvature >30 degrees after skin release and...
dartos dissection. It is also clear that transection of the urethra plate at this point usually does not straighten the penis, as Baskin and colleagues published [2]. Unless one uses multiple dorsal plications, it is not clear how these boys, especially with scrotal to perineal hypospadias, can uniformly be straightened without some form of ventral lengthening.

PH: From the answers to this and earlier questions, one can read consensus on the 30-degree curvature. So it seems that not all curvatures need surgical correction, and furthermore it seems that the focus is on surgery on the dorsum of the penis, avoiding the ventral side. This seems to be wise as we have no idea about the risk of performing ventral corporal grafting in prepubertal penises. And if there were consensus there would be wide disagreement on the material to use. This again is in conflict with the consensus on treatment of Peyronie’s disease, where the venous patch is the preferred substitute for corporal grafting [2].

Curvature correction is probably the most under researched part of hypospadias correction. We should be aware that we are working on the corpus cavernosum, which is the organ responsible for erection. To date, the long-term outcome of early surgery on this organ has not been studied. The impact of its function on psychosexual development is crucial, and an essential component of later quality of life. We should be more critical on this issue.

Question 11: When and how do you choose the technique of urethroplasty?

PM: It is once the ventral and lateral aspects of the penis have been fully dissected that the surgeon can identify three essential parameters [9]: 1) the level of division of the corpus spongiosum, 2) the quality of the urethral plate, and 3) the length of urethra to be reconstructed. The availability of the foreskin is known from the first visit of the patient. I keep all surgical options open until I reach this surgical stage. If the urethral plate is wide and healthy with a deep glanular groove and if the length of urethroplasty to be performed is \(<2\) cm, a urethral tubularization may be an alternative (Thiersch Duplay). If the urethroplasty is short (\(\leq1.5\) cm) and if the distal circular urethra is not hypoplastonic, I would consider a Koff urethral mobilization. If the urethroplasty is short (\(\leq2\) cm) and if the urethral plate is healthy but not wide enough to be deployed, I would then consider a TIP urethroplasty. For longer urethroplasties (\(2<2\) cm), I favor the onlay urethroplasty and for perineal hypospadias a Koyanagi–Hayashi procedure. For redo operations without available prepeue, requiring a short urethroplasty (\(<2\) cm) I would consider either a Mathieu or a Koff urethroplasty or an inlay buccal urethroplasty. For longer redo urethroplasty without available prepeue, an onlay or inlay buccal urethroplasty is often the best choice. There are particular situations in which I would consider a Cloutier-Bracka procedure, although since the popularization of the Koyanagi–Hayashi procedure the benefit of a two-stage procedure seems less obvious.

AM: Distal hypospadias, nice urethral plate, urethral defect not longer than 2 cm: either a Duplay or TIP repair (not so wide plate). Same conditions but when a longer urethroplasty is needed, we prefer a Duckett onlay island flap. For proximal hypospadias, there is no need for urethral plate division; again an onlay island flap is our choice. For proximal hypospadias with division of the urethral plate, we prefer to reconstruct the urethral plate with inlay buccal mucosa, perform an onlay island flap urethroplasty, protect the neourethra, and cover it with a tunica vaginalis and cremasteric flap (the three-in-one concept). Cripple hypospadias are better treated with a two-step Bracka procedure.

WS: Urethroplasty is determined by ability to preserve the urethral plate. We recently published our experience of over 500 consecutive distal hypospadias repairs, demonstrating that TIP repair can be used in all such cases with low complication rates [3]. Currently in 75% of patients with proximal hypospadias, associated penile curvature is corrected without plate transection and TIP is performed. In the 25% with plate transection for straightening, a two-stage graft procedure is used, with prepuce graft in patients undergoing circumcision and oral mucosa from the lower lip in conjunction with prepucioplasty.

My data from proximal TIP repairs demonstrates a statistically significant reduction in postoperative complications from an initial 5% to 25%, and most recently to 13% [4]. At this point, the 13% complication rate is statistically the same as my 4% complication rate in distal TIP repair — no other currently used technique achieves the same results. It should also be emphasized that there are no long-term data available on patients followed through puberty for any currently used technique.

Some surgeons wish to categorize the ‘health’ of the urethral plate, but my data comprise consecutive patients with proximal hypospadias, of whom only 3% had an obvious deficiency of the subepithelial tissues that precluded suturing. A recent survey of specialist using photographs to judge ‘health’ of the urethral plate found little agreement among observers, and only ‘moderate agreement’ when observers were given a second look at the same picture! [5]. The history of hypospadias is littered with subjective assessments, an obvious example being that ‘chordee’ tissues were fibrotic bands requiring excision — until histologic studies failed to reveal these bands. Subjective characterizations of the urethral plate and other ventral tissues do not advance our understanding nor improve our surgical results.

PH: No consensus but some trends. Judge the quality of the urethral plate and then decide if you will close it without incision or close it with incision, and I would add with grafted incision. There will be consensus on the wide and healthy well vascularized plates; however, this judgment is very subjective. Once you have subjectively decided that a plate is not wide enough or not healthy enough, tissue will be added in either an onlay fashion or as a two-stage procedure. When the plate needs transection there is the Koyanagi–Hayashi or two-stage procedure. It seems that a tubularized Duckett flap is now history, although Koyanagi (mainly also a tubularized urethroplasty) still needs longer follow up to stand the test of time.

WS: This issue of urethral plate ‘quality’ arises again! And again I object to this subjective assessment — my data on TIP is intention to treat, i.e. all patients are to undergo TIP unless ventral curvature prevents it. That has left only 3% of patients with a urethral plate that just could not be
tubularized for other reasons, such as a lack of subepithelial connective tissue that makes suturing impossible.

**Question 12: How do you assess the quality of the urethral plate?**

**PM:** The length, width and thickness of the urethral plate evaluated after full dissection of the ventral aspect of the penis are the criteria I use to assess the quality of the urethral plate. I accept that this is subjective and is essentially based on the surgeon’s experience. The temptation to create a mathematical model for hypospadias is far too simplistic and should be avoided, as well as algorithmic surgery. We should adjust the repair to each individual patient and not the patient to a rigid flow chart.

**AM:** Thickness is important for a safer TIP repair, whereas width is important to decide if a longitudinal incision is even needed in distal repairs. Quality of the urethral plate alone is not enough to confirm good results because glanular shape should be considered too as ‘the distal part of the urethral plate’. In my opinion, each surgeon defines, after a couple of unsuccessful cases, their own concept of what is a bad quality urethral plate. In other words, assessment is subjective.

**WS:** Before we can ‘ Assess’ quality we must first define ‘quality’. Is it width and, if so, before or after midline incision? Is it midline groove, although incision ‘ deepens ’ a flat plate? Is it elasticity and, if so, how much ‘ stretch ’ should it have and how is that determined? Given that surgeons are unable to define urethral plate ‘ quality ’, this discussion reminds me of the famous statement by a US Supreme Court Justice who admitted he could not define pornography, but he knew it when he saw it!

If the urethral plate can be preserved during straightening maneuvers described earlier, then my data indicate it can almost always be incised and tubularized to create the neourethra. The reduction in my complication rate from 54% to 13% was achieved by technical modifications, not by different selection of cases based on some aspect of the urethral plate. In fact, the series with the lowest complications included patients with the most extensive dissections to preserve the urethral plate, implying there is not much clinical variability between plates even though they may look different. This is our same observation with distal hypospadias repair, where TIP was possible in over 500 consecutive patients with few complications despite no urethral plate ‘ assessment ’.

Each of us admits we use more than one technique in our personal algorithms to address the spectrum of primary and reoperative hypospadias. Within these algorithms, none of us are forcing an operation on a patient if the operation works for that patient, nor do we need to devise hundreds of additional procedures for the innumerable anatomic variations comprising hypospadias.

Furthermore, we should strive for decision-making based on outcomes, not ‘ surgeon experience ’ – a term that usually really means surgeon preference. Now I wish to pose a provocative question to my co-authors: If proximal TIP can be done with complication rates just over 10%, while onlay and various tubularized preputial flaps have complication rates of 30% to over 50%, is your preference ‘ forcing ’ an operation on a patient when a potentially better choice is available? Please do not respond that you have concerns for long-term TIP outcomes (so do I!), since there are essentially no long-term outcomes known for these alternative procedures either.

**Question 13: In a penis with a normally sited urethral meatus and a poorly developed ventral aspect, do you consider re-fashioning the urethra, or do you limit your procedure to a spongioplasty associated or not with a corporeal plasty?**

**PM:** I think both options are valid. It really depends on the quality of the pillars of atretic spongiosum. When the prepuce is available, I tend to redo the whole urethra using an onlay urethroplasty.

**AM:** It depends on whether the integrity of the urethra can be maintained after degloving the penis. If the urethra proximal to the urethral meatus is poor, it may be safer to incise the hypoplastic urethra up to its normal portion. If the meatus is still apical, it is also possible to reinforce the urethra by approximating the two pillars of spongiosum above the urethra and covering the whole repair with a dorsal Scarp flap. The glanular portion of the urethra is reinforced by the approximation of the two glans wings above the thin urethra.

**WS:** This is an uncommon situation, and intervention depends on the ability, or not, to dissect the shaft skin from the urethra. It is less the divergent spongiosum than the subepithelial tissues over the urethra that determine appropriate management, if such a patient needs any intervention.

**PH:** I agree that it is even harder to give a written answer to this question as mostly what you will do will depend on what you get after degloving the penis. Furthermore, it is a rare condition.

**Question 14: Do you reconstruct the foreskin?**

**PM:** I don’t like reconstructing the foreskin as I often found the cosmetic and functional result disappointing. If the parents insist, I will do it.

**AM:** Foreskin tissues are often needed when there is a deficit of ventral skin. If not, reconstruction of the foreskin is possible although with a disappointing cosmetic aspect. We recommend therefore circumcision in most cases.

**WS:** Who should judge cosmetic outcomes, the surgeon or the patient/family? Urethroplasty can readily be done without using foreskin, leaving the option for preputioplasty in essentially all patients undergoing hypospadias repair. I simply ask the parents if their plan for their newborn baby was to perform circumcision or not, and then manage the skin accordingly.

**PH:** No full consensus. The question should be: can a hooded prepuce be reconstructed in a normal looking and functioning prepuce? Due to the hooded aspect with prominent dog-ears, the answer to the first remark is that it will be difficult to make it look normal. As for function, we should consider that narrowing of the reconstructed foreskin is often a problem, and in my hands I observed often a tethering of the ventral reconstructed foreskin to the ventral aspect of the glans causing tilting of the glans while...
the penis is in erection. Although unpublished as yet, I found in my long-term data that in half of the boys that I reconstructed the foreskin came back after puberty with this problem of tilting for which circumcision needed to be done. Again, an argument for long-term follow up.

WS: I would strongly encourage you to publish this if you have such data. I hear comments like this from time to time — Aivar Bracka has said the same, although he has never done foreskin reconstructions — but if this is a real issue then we need that data to assist parents in decision-making. Unless you have reviewed your data and know that 50% of reconstructed patients ask for circumcision, it may be unfair to make this estimation, as readers will assume it is accurate. Meanwhile, we have just completed another review of my foreskin reconstruction data, and there have been no patients undergoing a secondary circumcision for cosmetic reasons (in fact only one has been needed, for balanitis xerotica obliterans that developed several years later).

PM: I have the same views as Piet on the cosmetic and functional outcome of reconstructed foreskin. I have rarely seen nice results even coming from other centers, and secondary circumcisions are not uncommon in my experience.

Question 15: Beside your favorite technique of repair, what technical aspects would you consider as important in the success of this surgery?

PM: To succeed in hypospadiac surgery, one has to be completely obsessional. Each detail counts. Each surgeon has their own habits which should be respected as long as the results are there. I would probably insist on the quality of the dressing, which has several roles: 1) to keep the penis still for the first few days following the procedure; 2) to reduce postoperative discomfort; 3) to stop any residual bleeding. We favor the so-called ‘daisy dressing’ which has been described in other publications.

AM: The postoperative course is fundamental. The non-touch strategy in the first four postoperative days is important. We favor a bioclusive dressing, the use of tissue glue for the glans suture and urinary drainage according to age: contingent silicone stent if the child is still in nappies and the combination of urethral stent only in the neourethra and cystostomy tube for complex cases in older patients.

WS: Unfortunately, the hypospadias literature lacks sufficient detail to determine factors impacting success. For example, few reports list sutures/needles used for urethroplasty, glansplasty or skin closure, or whether these steps are done in one or two layers, with sutures through epithelium or subepithelial, with continuous or interrupted stitches. Another pertinent question in proximal hypospadias repair is whether the duration of urinary diversion matters? A surgeon who has difficulties with fistulas cannot compare his technique to another’s reporting fewer fistulas using the same operation to learn how to improve his outcomes, because such details are lacking. We speak of surgeon preference, when what we mean is surgeon opinion, in the absence of objective data.

PH: Some consensus on dressing, and indeed I believe that ‘dry immobilization’ might contribute to outcome. Immobilized tissues heal better and the immobilization helps to reduce the pain. Keeping the wound dry for some days seems an important factor for healing. But as stated by one of the surgeons there is no evidence as there has been no prospective comparative study to support our expert opinion.

WS: There are two prospective dressings studies that state dressing or no dressing makes no difference in urethroplasty outcomes.

PM: Our nurses compared four different types of hypospadias dressing and elected the ‘daisy dressing’ as their favorite to avoid postoperative pain and bleeding. As I am not doing any coagulation during this surgery, the dressing plays an essential role in keeping the penis dry after surgery.

Postoperative evaluation

Question 16: When do you see the patients again after reconstruction?

PM: 2 months; 12 months; at puberty when possible and in case of dysuria or urinary tract infection.

AM: My protocol to see the patients is: next week, 1 month, 6 months, and thereafter is optional for the next year or if there are any questions.

WS: Duration and means of follow up needed to detect the majority of complications remain ill defined, in large part because the time complications were first encountered is rarely reported. Although occasionally a boy recently toilet-trained will be noted to have a pinhole fistula not previously seen when he was in diapers, or rarely a child will develop obstructive voiding symptoms many years later and be found to have meatal balanitis xerotica obliterans, it appears from my data that most problems are detected within the first 6 months following surgery.

However, there are also questions regarding long-term outcomes, especially after proximal repairs, which are the emphasis of this discussion. Given our academic interests, I recommend follow up at 6 weeks, 6 months, and annually in these boys. However, maintaining contact with boys seemingly doing well is difficult, and I note that despite the common statement that follow up is needed at puberty, there are essentially no reports documenting such follow up at puberty — even from European centers within national healthcare systems dealing with patients who tend to move less often and within a smaller geographic area than we face in the US.

PH: I will add my argued protocol here. I see them back 2 months after surgery, at age 3, when they are supposed to be toilet-trained during the day; at age 6 when they are supposed to be dry during the night; and after puberty when they are supposed to be in a way sexually active. This protocol allows me to judge the functional outcome in the long term. So, indeed: four experts, four protocols. It will be difficult to standardize this.

WS: It would be interesting to know how successful such recommendations are in your healthcare environment. It is often stated patients need long-term follow up, but in the US it can be difficult to get even short-term assessment (6 months), and impossible to have long-term results. It would make an interesting report for Piet or Pierre to go back 15–20 years and see how many of the patients operated then returned for assessment at puberty, and what were the findings. In fact, I submit that agreeing to a minimum follow-up protocol would be easier than many

other aspects, once we learn how many patients actually have long-term follow up in Europe. My suspicion is that follow up at puberty is actually rare in Europe also, or there would have already been reports on those outcomes.

PM: This is, I think, a major difference between US and European practice. Long-term follow up is an essential issue and to evaluate a technique with only short-term results does not allow to state that this technique is a ‘gold standard’. There is no ‘gold standard’ technique, there is no ‘universal’ technique, and the past decades taught us that we have to be extremely humble about hypospadias surgery. There are questions about the growth ability of ventral tissues sitting beyond the division of the corpus spongiosum. We see a significant number of patients who underwent a Duplay/TIP repair who become dysuric several years after the operation. This may be interpreted as being due to a variable capacity of penile growth between ventral and dorsal tissues. This is the reason why long-term follow up is important.

Question 17: How do you assess the results?

PM: This is the weakest point of most studies. The cosmetic and functional assessments of hypospadias are often subjective. I would first evaluate the patient and parents’ satisfaction in terms of comfort, dysuria and urinary tract infection. When possible, I observe the child passing water, although this only gives a general impression. I do not trust urine flow studies which often produce flat curves despite satisfactory urethroplasty. Most repaired urethras have an abnormal compliance due to the material used. Children after urethroplasty frequently have dyssynergic micturitions which flatten the urine flow curves. In the case of dysuria, I would consider an examination under general anesthetic with urethrocystoscopy and possible calibration. I would certainly not calibrate asymptomatic hypospadias. After surgery, most hypospadiac children present with dysuria but not all dysuria requires further surgery. Patients have a remarkable capacity to adjust their micturition to the degree of dysuria they have. Only those who can’t achieve this adjustment will consult again.

AM: Urethral meatus wide open and apical? We then observe micturition at the 30th postoperative day (toilet-trained) whereas for the non-trained we ask parents for comments. If it is fine, we re-evaluate 6 months later. Then we ask for urinary complaints and allow parents to give their opinion regarding final cosmesis.

WS: I pass an 8- or 10-Fr sound in babies 6 months after surgery to document absence of either meatal stenosis or urethral stricture. This is not a recommendation for others to emulate, but without this data uncertainty would remain regarding healing after TIP repair.

After toilet-training we obtain uroflowmetry and ultrasound-measured post-void residual urine volume. Uroflowmetry is frustrating in children, as despite multiple admonitions to parents to have the boy urinate with a full bladder, most often voided volumes are less than 100 cc. I agree with Pierre that the shape of the curves also has uncertain significance. Certainly the neourethra, constructed by whatever technique, is not a normal urethra.

Although peak flow rates and uroflow curve rates have unclear meaning, I recommend urethroscopy when there is a flat tracing with a flow rate less than 5 cc/s, and/or in patients with obstructive voiding symptoms. Both are rarely encountered.

Neourethras may cause spraying urinary streams and post-void dribbling. Specific queries on these issues should be made to school-age and older patients.

PH: Here, we read wide expert disagreement or, otherwise stated, there seems to be no objective way to judge results. Esthetic outcome judgment is very difficult to do, and requires an independent observer using a standardized checklist. As for functional outcome, I personally would never use urethral calibration as it must be considered invasive and painful, especially in those children who have a relative meatal stenosis. The comments on the low value of uroflowmetry are correct; however, I have the impression that with age curves tend to normalize, which reflects the growth of the penis and thus the widening of the reconstructed urethra due to growth. In my view, the functional outcomes in the long term for continence and sexual function, combined with patient satisfaction, are those that are important to judge.

Conclusion

Question 18: How many cases do you perform each year?

PM: Our unit sees a mean number of 160 patients each year and I would do approximately 120.

AM: Approximately 80 cases a year, but interestingly 50% primary proximal and secondary repairs (mostly referred) and 50% distal cases.

WS: In 2009, I performed 72 primary distal repairs, 20 primary proximal repairs, and 32 reconstructions, including 12 two-stage buccal graft procedures, in Dallas.

PH: From the answers it reads that you should do around 100 cases per year to be called an expert hypospadiologist. I agree with that, doing myself approximately 3 cases per week.

WS: In addition to doing a large number of cases, reviewing results should be part of becoming an ‘expert’.

Question 19: Do you think that any pediatric urologist/pediatric surgeon/urologist can do a hypospadias repair, or do you think that a minimal number is needed to be competent?

PM: Hypospadias surgery remains a challenge even in the best hands. I don’t think it should be recommended to perform this surgery occasionally, even for anterior hypospadias which can be trickier than some posterior cases. Minor hypospadias does not exist. It appears more and more clearly with time that DSD surgeons dealing with male and female abnormal genitalia should be identified.

AM: Everyone dealing with hypospadias should be able to cover any form of hypospadias, from the most distal to the most proximal ones. Otherwise he should refer to a specialist.

WS: A minimum number of cases to establish or maintain competency in hypospadias repair has never been established. I performed an average of only eight hypospadias repairs per year before moving to Dallas, yet my results with distal TIP have not changed from the initial 16 published in 1994 [6] to the more recent 426 reported this year [3]. As
mentioned earlier, my complication rate in proximal TIP repair has decreased as a direct result of technical changes during the past 10 years, but by following recent published recommendations others should be able to obtain similarly good outcomes without enduring the same learning curve.

Having said that, most hypospadias ‘cripples’ began life with proximal hypospadias. Commonly used techniques to repair them, including tubularized preputial flaps and Byar’s flaps, have complication rates greater than 30% in most reports, and there has been no series published showing a reduction in these complications through technical changes such as has been accomplished with TIP repair. Furthermore, demographic analysis in the US suggests an even distribution of proximal hypospadias cases would result in each pediatric urologist operating on no more than four cases per year. Given fewer patients with higher expected complication rates, it seems better for individual surgeons to be identified within groups in major centers to perform these cases, with the goal of increasing our knowledge for best management as well as providing improved care for these patients.

PH: From most answers given to all the questions, it seems that experience is the basis of the personal treatment strategies of the three experts. We know that all three experts have reported good results with their approach, so we know that despite different approaches they obtain comparable results. From this observation, I learn that the clue to becoming a successful hypospadiologist is double: be intellectually interested in hypospadias and perform a high number of cases.

WS: Again, I would add that reviewing results to actually verify outcomes should be part of hypospadiology — but is not done by the majority of surgeons.

**Question 20:** We all have reservations when reading an article reporting the results of such or such a technique. What advice or canvas would you suggest to improve future reports and make them comparable to others?

**PM:** Appendix 1 gives the information we wish to collect for each patient. Although most publications are retrospective, attempts should be made to solely focus on prospective studies.

**AM:** First of all, we have to agree the same classification and goals of treatment.

**WS:** The goal of scientific reporting is to share information to benefit others. Any article concerning a surgical technique should clearly state who the patients are, specifically describing who was operated and who was not, and why. Readers need to be able to visualize the study patients to be able to compare their own experience. The surgical technique must be described in sufficient detail that an unfamiliar reader could perform the procedure, and a reader who already uses the same technique can see how his method compares and contrasts to that being reported. How many patients had follow up, and for how long should be stated. Means to determine outcomes must be described — as we discussed above regarding hypospadias repair. After hypospadias repair, authors should clearly state how many patients had fistulas, meatal stenosis, urethral stricture, glans or complete repair dehiscence, or diverticulum formation — even if the answer is zero for some of these potential events — and when they were first noted.

My earlier papers did not meet this standard, and, ironically, recent ones attempting to do so have been met with objections from some reviewers that they contain too much surgical detail! But understanding of this condition and its correction cannot progress without better reporting, and so it is the duty of reviewers and editors to insist authors submit more thorough manuscripts.

**Question 21:** How are you going to improve your hypospadias surgery?

**PM:**
- The material used to reconstruct the missing urethra needs to be constantly challenged. Bioengineering was and still is a hope for the future to reconstruct the defective urethra with a more adequate material able to reproduce a normal urethral dynamic.
- Long-term evaluation is crucial and should be a prospective process following consensual guidelines.
- Glans sensitivity has been so far ignored although it is a major issue in feminization procedures.
- Preoperative assessment needs a lot more thought to select patients who require biological screening.
- Pre-operative penile preparation might be an essential step to improve the outcome of this surgery.
- Psychological support for some is an essential issue, particularly when several procedures are needed.

**AM:** The only way to improve results is to gain more experience, assess the complications met, and learn from them. Contact with other experts is always useful.

**WS:** When I moved to Dallas 11 years ago I was concerned my charts from Lubbock would be lost, with data from my initial TIP repairs. A resident suggested I record information using an Excel spreadsheet, and after doing so I immediately realized the potential power of this list of consecutive patients that included information regarding preoperative testosterone use, meatal location, ventral curvature, suture materials and techniques, barrier layers over the neourethra, time of follow up, use of calibration, uroflowmetry and/or urethroscopy, and complications. Today, separate spreadsheets list primary distal, midshaft and proximal repairs, and reoperations by TIP, inlay grafting or two-stage buccal grafts. Together, they comprise prospectively maintained data on more than 1100 patients. It takes less than 30 min to record pertinent data after a day in either the operating room or outpatient clinic.

From these data I very quickly determined that my initial 15 patients with proximal TIP had a 54% complication rate. The results of subsequent, specific changes in technique were just as easy to assess in subsequent patient cohorts, documenting a reduction in complications that now are statistically the same as in distal TIP repairs. This same process identified the importance of a dartos flap in TIP reoperations to prevent fistulas, and the need to use oral grafts obtained from the lower lip, not cheek, within the glans in prepubertal boys to reduce glans dehiscence.

I have not had a fistula after a proximal hypospadias repair in 4 years. Meatal stenosis and urethral stricture remain nearly anecdotal occurrences. Today, my most
common complication is glans dehiscence, a problem likely under-reported. As discussed above, I now measure glans size and recommend testosterone preoperatively to address this concern — and record this data prospectively. Another strength of spreadsheets is the ability to simply add new categories for analysis as new questions arise.

Even if a surgeon has no intention of publishing his work, maintaining such databases — even for only a year or so — will provide important information to see if results are being obtained similar to what the literature reports. Quality assurance should be a standard aspect of professional life, but is an area of medical education and practice that has not received much attention. It is only through such simple means that knowledge will grow and the era of decision-making by ‘surgeon preference’ will finally give way to an era of decision-making based on data.

PH: It is clear that if we want to improve the reports on outcome of hypospadias repair we will have to perform prospective studies with long follow up and with standardized evaluation. Appendix is a good example of how we should try to standardize our databases in order to report with comparable data. This will mean that we will have to do more administration, but as medical doctors we must do this as it has implications for any future patient. We should think about guidelines and standardization; we should try to gather experienced people from all over the world and get consensus. This is how the standardization document on DSD was generated, and this is how a future standardization document on hypospadias should see the light.

And this issue is also addressed in the answer to Question 20 by WS on decision-making based on data rather than on surgeon preference, which I fully support and believe is the only way to go. The only thing to decide is which data, because there are so many things to be followed after genital surgery in general. We should remember that the penis is the male urogenital system and that it has two functions: to be the conduit for urine and for sperm. Behind these two simple functions are a lot of evaluations to perform. And just as an example of what I have missed in this interesting discussion on hypospadias dilemmas, is the long-term psychosexual outcome.

Appendix 1

1 Clinical evaluation of the genital tubercle

1-1- Outpatient Department

- Age of the child
- Asymmetrical genitalia
  o Yes
  o No
- Dorsal length of the tubercle
- Width of the tubercle
- Ventral aspect of the penis (length of hypoplasia)
  o Distal
  o Midshaft
  o Proximal
- Position of the meatus
  o Distal
  o Midshaft
  o Proximal
  o Complete
  o Open
- Ventral curvature
  o Yes
  o No
- Foreskin
  o Hooded
  o Complete
- Gonads
  o Normal
  o Undescended palpable
  o Non palpable
  o Abnormal palpation
- Scrotums
  o Normal
  o Hypoplastic
  o Transposition
  o Incomplete fusion
- Associated genital anomalies
  o Undescended testes
  o Mullerian cavity
  o Micropenis
  o Other
- Other non-genital anomalies

1-2- Preoperative hormonal stimulation

- Androgens
  o Type
  o Dose
  o Timing/surgery
- Other

1-3- Preoperative psychological assessment

- No
- Yes (comments)

1-4- Operating room: Anatomical description after dissection of the ventral aspect of the tubercle

- Age of the child at surgery
- Photo
- Size
- Level of division of the corpus spongiosum
  o Distal
  o Midshaft
  o Proximal
- Position of the urethral meatus
  o Distal
  o Midshaft
  o Proximal
- Quality of the urethral plate
  o Good
  o Poor
- Curvature
  o Checked
    ■ Yes
    ■ No
  o Significant
  o Not significant

1-5 Procedure

- Length of the reconstructed urethra
- Urethroplasty
  - Duplay/TIP
  - Mathieu
  - Onlay
  - Koff
  - Bracka
  - Koyanagi/Hayashi
  - Other
- Correction of chordee
  - No
  - Yes
    - Nesbit
    - TAP
    - Ventral plasty
    - Other
- Foreskin
  - Reconstruction
  - Circumcision
- Immediate postoperative result
  - Meets expectations
  - Does not meet expectations (details)

2 Outcome

2-1 1st postoperative consultation

  - Patient’s (parents’) satisfaction
    - Patients’s (parents’) satisfaction:
      - Satisfied
      - Not satisfied (comments)
    - Quality of micturitions
      - Pain
        - Yes
        - No
      - Urinary tract infection
        - Yes
        - No
    - Micturition duration
      - Unremarkable
      - Too long
    - Straining
      - Yes
      - No
    - Aspect of the urine jet
      - Normal
      - Does the child sit to pass water
      - Yes
      - No
      - Spraying
      - Yes
      - No
      - Thinness of the urine stream
        - Yes
        - No
      - Pressure of the stream
        - Unremarkable
        - High (urine spillage)
      - Foreskin (when kept)
        - Retractable
        - Non-retractable
        - Cosmetic appearance
        - Satisfactory
        - Unsatisfactory
      - Erections
        - Unremarkable
        - Not seen
        - Persistent curvature
      - Physician’s evaluation
        - Photo
          - Yes
          - No
        - Cosmesis
          - Satisfactory
          - Unsatisfactory (comments)
        - Function
          - Persistent curvature
          - Observed micturitions
      - Urine flow study
        - Yes
        - No
      - Ultrasound scan
        - Yes
        - No
      - Bladder wall thickness
      - Post-micturition residue
      - Complications
  - Insufficient cosmetic result
  - Glans dehiscence
  - Meatal stenosis
  - Urethral dehiscence
  - Fistula
  - Stenosis
  - Non-retractable foreskin
  - Persistent chordee
  - Urethral prolapse
  - Penile twist
  - Other

2-2 Follow-up visits: 12 months/Puberty

  - Same assessment

2-3 Further surgery

  - No
  - Yes
Hypospadias dilemmas

- Type:
  - When/1st operation

3- Biological evaluation

3-1- First day of life:
  - Testosterone + precursors
  - AMH
  - Inhibin B
  - Karyotype
  - Other

3-2- Minipuberty: Day 15 – Day 90
  - Testosterone + precursors
  - AMH
  - Inhibin B
  - Karyotype
  - Other

3-3- After Day 90
  - Testosterone + precursors after HCG test
    - HCG test protocol
    - AMH
    - Inhibin B
    - Karyotype
    - Other

4- Psychological evaluation
  - No
  - Yes (comments)

Appendix 2
Pierre Mouriquand’s references


Appendix 3
Warren Snodgrass’ references


Appendix 4
Piet Hoebeke’s references