Oral Contraceptives combined with Folate to Improve Folate Levels and Decrease Neural Tube Defects

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I- Importance of Improvement of Folate Levels

Folate is an essential B vitamin for DNA synthesis and normal cell division and is consequently required by rapidly dividing cells, such as blood cells, cells lining the gastrointestinal tract or, in pregnant women, the developing fetus (1-3). Adequate folate intake also contributes to a wide range of other essential health functions including normal amino acid synthesis, immune function and homocysteine metabolism (1, 4, 5).

There is a large medical evidence confirming ***that folate supplementation in the periconceptional period significantly reduces the risk of Neural Tube Defects (NTDs*** (6-18). While recommendations for periconceptional folate supplementation have been developed in Europe (19, 20) and USA (21), intake of folic acid supplements remains suboptimal (22-24).

There remains a medical need for additional strategies which ensure that women of reproductive age consume sufficient amounts of folate.

II- Neural Tube Defects (NTDs)

NTDs are among the most common congenital abnormalities contributing to neonatal mortality and morbidity, secondary only to congenital heart defects (25). ***They occur when the neural tube fails to close completely within 28 days post-conception, often before a woman realizes she is pregnant*** (26). It is scientifically evident that folate supplementation in the periconceptional period can reduce the risk of NTDs by up to 70% (27-28).

Anencephaly and spina bifida are the most common NTD types. Annually, an estimated more than 300,000 newborns are affected by NTDs worldwide, although the prevalence of NTDs varies greatly between countries (26, 29). Anencephaly is characterized by an open neural tube in the cephalic region with total or partial absence of the brain and skull (26). Spina bifida is characterized by herniation of the meninges and or neural tissue through a bony defect in the posterior vertebral arches (25). The prognosis of NTDs varies considerably according to the defect type: anencephaly is incompatible with survival and all affected infants are stillborn or die soon after delivery. However, most infants born with spina bifida survive, suffering from disabilities such as paralysis, loss of bladder and bowel control, hydrocephalus and learning disabilities, hence compromised health-related quality of life (30-37).

The etiology of NTDs is not fully understood but thought to be multifactorial; however, the development of an NTD is considered to be influenced by both genetic and environmental factors: Evidence for a genetic contribution to the development of NTDs is based on an association between NTDs and chromosomal and single-gene disorders, and an increased recurrence of NTDs in siblings (38-40). Many environmental factors are thought to predispose to NTDs. The factor that is considered to play a major role is maternal folate status in the periconceptional period (41). ***The risk of an NTD-affected pregnancy reduces as RBC folate levels increase. It has been calculated that periconceptional maternal RBC folate concentrations of 906 nmol/l (ng/ml) or higher are associated with a very low risk of NTDs (0.8 per 1,000 births)*** (41).

III- Why Is the Reduction in the Incidence of NTDs Below Expectation?

- There are currently three possible ways to increase women's folate intake:
  1- Increasing consumption of food rich in naturally occurring folate
  2- Consuming food fortified with folic acid
  3- Taking folate supplements as in pills.
- However, even with the implementation of these strategies, decreases in NTD rates have fallen short of expectations (42-43), as outlined below:

A- Increased intake of foods naturally rich in folate is relatively ineffective:

- Natural folate is found in a variety of foods, including broccoli, leafy green vegetables and citrus fruits (1).
- Natural food folates have limited ability to boost folate levels due to their incomplete bioavailability and poor stability under cooking conditions (44).
- Many natural folates need to be metabolized before they become biologically active (1).
- A typical diet, as consumed in most western countries, does not generally provide enough folate to achieve the levels associated with the lowest risk of NTDs (45).
- Women with certain polymorphisms of folate-converting enzymes have difficulty metabolizing some natural folates (1, 46).
- Therefore, increasing consumption of foods naturally rich in folate is a relatively ineffective means of boosting folate levels compared with folic acid supplementation or consumption of fortified foods (45, 47, 48).

B- Effect of fortification of foods with synthetic folic acid is below expectations:

- In most developed countries, the mean dietary folate intake in women is below the recommended nutrient intake as defined by the World Health Organization (WHO) (49-51).
- Food fortification with synthetic folic acid represents a non-targeted approach to increasing folate intake, as all members of society may consume fortified foods (52).
- By 2012, 74 countries worldwide had national regulations for mandatory fortification of wheat flour with folic acid, with or without iron (53). Mandatory food fortification has not yet been introduced in Europe due to the potential as-yet-unknown risks of fortification to the general population (54).
- In 1998, the Food and Drug Administration (FDA) mandated that all cereal grain products be fortified with folic acid 140 µg/100 g in order to increase folic acid intake in the general population by 100 µg/day (55-56). However, following increases in serum folate levels, a decline in both plasma and RBC folate levels has been observed since 2000 in the USA (57-58).

C- Periconceptional dietary folate supplementation is often underused:

- There is a large body of evidence confirming that folate supplementation in the periconceptional period significantly reduces the risk of NTDs (6-18).
  A Cochrane review of five randomized trials showed a protective effect of daily folic acid supplementation in preventing NTDs (risk ratio 0.28 with a 95% confidence interval 0.15-0.52) compared with placebo or vitamins and minerals without folic acid (27).
- Many health authorities worldwide recommend folate supplementation, for example:
  - Most European governments and/or national societies recommend periconceptional folic acid intake of 400 µg daily for at least one month prior to conception and for the first three months of pregnancy (19-20).
  - In the USA, current recommendations specify that all women planning or capable of pregnancy should take daily supplementation with folic acid 400-800 µg. Folic acid supplementation should start at least one month before conception and continue daily throughout the first three months of pregnancy (21).
- Folate intake is needed well in advance of conception to reach adequate folate levels at the time of neurulation. There is large data to suggest that the recommended period of preconceptional folic acid supplementation should be increased from four to 12 weeks in order to achieve maximum NTD risk reduction (59).

D- Many women find it difficult to remember to take a vitamin pill on a regular basis (60):

- Only 40% of fertile-aged women in the USA take folic acid supplements on a daily basis (22).
- In the National Health and Nutrition Examination Survey (NHANES), 24% of non-pregnant US women of childbearing potential consumed the recommended folate intake (24).

• Data from the European Surveillance of Congenital Abnormalities (EUROCAT) registry showed that, in all European countries except the Netherlands, only in minority of women took folic acid supplements during the entire periconceptional period as recommended. The highest uptake in the studies was recorded in the Netherlands, UK, Switzerland, Hungary and Norway with 30-51% periconceptional intake. Extremely low intakes of <10% were found in France, Germany and Italy (23).
• In European women currently trying to conceive, 56% reported that they remembered to take their folic acid supplement every day (61).

E- Overall decline in NTDs has been suboptimal

• Decreases in NTD rates have fallen short of expectations, both in Europe and the USA (42-43).
• There remains a medical need for additional strategies which ensure that women of childbearing age consume sufficient amounts of folate.

IV- What Is the Rationale for COC + Folate?

A- Targeted approach to folate supplementation

• Fortification of a Combined Oral Contraceptive (COC) builds on the approach of food fortification, and targets women of reproductive age who need it most, and can deliver folate at a consistent, controlled dose.
• In contrast to a food fortification approach affecting the entire population, addition of folate to a COC represents a more targeted approach (52).
• Addition of folate to a COC also represents a unique counseling opportunity for physicians, enabling them to highlight the benefits of folate supplementation in women who are not yet contemplating pregnancy, or who are unaware of the benefits of folate (62).

B- Timely intake of folate supplementation

• As outlined previously, ***NTDs occur within the first 28 days of conception i.e. within 14 days after the first day of missed periods*** (26).
• Many women, however, do not have optimal folate levels at the time of conception, due to various factors including:
- Lack of awareness:
  • In a 2010 survey of nearly 23,000 women in 18 European countries, of the women with children who were currently aware of the benefits of folate, only 35% knew about folic acid's benefits related to birth defects while thinking of becoming pregnant and/or stopping contraception to become pregnant; of these women, only half started taking folic acid before they found out they were pregnant (61).
  • In this same survey, 56% of women with children did not consult their healthcare professional before trying to conceive (61).
  • These data are also supported by findings from another global survey of 900 physicians, whereby physicians reported that only 49% of their patients had informed them of their plans for pregnancy (63).
- Unplanned pregnancies
In a 2010 global survey of 4515 women conducted in nine countries, of the 40% with children, 36% of women reported that their first pregnancy was unplanned (63).
- Quick return to fertility
A study showed that women who stop their COC with the intention of becoming pregnant, may do so quickly; 21.1% become pregnant after one cycle and 45.7% become pregnant after three cycles (64).
- COC + folate can help to ensure that women of childbearing potential receive the recommended daily dose of periconceptional folate supplementation and may increase the likelihood of them having increased folate levels at the time of conception.
- As folate levels will decline continuously over time after stopping COC + folate, folate supplementation should be continued as soon as possible after cessation of COC + folate.

C- Regular intake of folate supplementation

As outlined previously, ***many women find it difficult to remember to take a vitamin pill on a regular basis*** (60).
In contrast, compliance with COCs can generally be regarded as high, as the consequences of one missed pill may be enough to be significant.
Combining a COC with the recommended daily dose of folate in a single pill offers the potential for improved folate status in COC users without requiring any change in pill-taking behavior.

V- Summary of Combination: COC + Folate

• Folate is a B vitamin that is essential for DNA synthesis and normal cell division (1,2).
• Folate is an essential vitamin that contributes to a range of health functions, including immune function, and amino acid synthesis (1,2,4,5).
• The risk of NTD-affected pregnancies can be reduced through adequate folate intake at the right time (27).
• Many women do not seek advice from their physician regarding the importance of folate supplementation (61,63).
• Many worldwide health organizations recommend supplementation with 400 µg/day folic acid in the periconceptional period (21,51).
• COCs would be a reasonable delivery vehicle for folate supplementation in women of childbearing age for many reasons:
- **Targeted approach** to folate supplementation
COC users are women of childbearing age, i.e. those members of the population in whom adequate levels of folate are of the greatest benefit.
- **Timely intake** of folate supplementation
Combining a COC with folate ensures that women of childbearing age receive the widely recommended daily dose of folate in the periconceptional period.
- Women who receive folate with their COC on a daily basis, and then continue to take a folate supplement as soon as they discontinue their pill, are more likely to have adequate folate levels at the time of conception.
- **Regular intake** of folate supplementation
Combining a COC, which has a generally high level of user compliance, with the recommended daily dose of folate in a single pill offers the potential for improved folate status in COC users without requiring any change in pill-taking behavior.

References

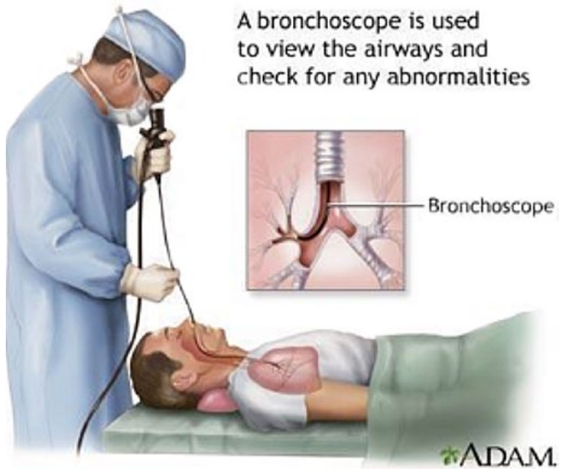
1. Greenberg JA, Bell SJ, Guan Y, Yu YH, Folic Acid. Supplementation and pregnancy: more than just neural tube defect prevention. Rev Obstet Gynecol.2011; 4 (2):52-9.
2. Human Vitamin and Mineral Requirements: Report of a joint FAO/WHO expert consultation, Bangkok, Thailand.2001.Chapter Four: Folate and Folic acid.
3. Bailey L. Folate in Health and Disease, 2nd Edition. Edited by Lynn Bailey.2009.
4. EFSA Panel on Dietetic products, Nutrition and Allergies (NDA). Scientific Opinion on the substantiation of health claims related to folate and contribution to normal psychological functions, maintenance of normal vision, reduction of tiredness and fatigue, cell division and contribution to normal amino acid synthesis. EFSA Journal. 2010; 8(10):1760.
5. EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on the substantiation of health claims related to folate and blood formation, homocysteine metabolism, energy-yielding metabolism, function of the immune system, function of blood vessels, cell division, and maternal tissue growth during pregnancy. EFSA Journal.2009; 7(9):1213.
6. Prevention of neural tube defects; results of the Medical Research Council Vitamin Study. MRC Vitamin Study Research Group. Lancet 1991; 338 (8760): 131-7.
7. Berry RJ, Li Z, Erickson JD, et al. Prevention of neural tube defects with folic acid in China. N Engl J Med. 1999; 341(20):1485-90.
8. Brower C and Stanley FJ. Dietary folate as a risk factor for neural-tube defects: evidence from a case-control study in Western Australia. Med J Aust. 1989; 150(11):613-9.
9. Chen G, Song X, Ji Y, et al. Prevention of NTDs with periconceptional
multivitamin supplementation containing folic acid in China.Birth Defects Res A Clin Mol Teratol. 2008; 82(8):592-6.
10. Czeizel AE and Dudas I. Prevention of the first occurrence of neural-tube defects by periconceptional vitamin supplementation. N Engl J Med. 1992; 327(26):1832-5.
11. Kirke PN, Daly LE, and Elwood JH. A randomized trial of low dose folic acid to prevent neural tube defects. The Irish Vitamin Study Group. Arch Dis Child. 1992; 67(12):1442-6.
12. Laurence KM, James N, Miller MH, et al. Double-blind randomized controlled trial of folate treatment before conception to prevent recurrence of neural-tube defects. Br Med J (Clin Res Ed) 1981; 282(6275):1509-11.
13. Milunsky A, Jick H, Jick SS, et al. Multivitamin/folic acid supplementation in early pregnancy reduces the prevalence of neural tube defects. JAMA. 1989; 262(20):2847-52.
14. Mulinare J, Cordero JF, Erickson JD, et al. Periconceptional use of multivitamins and the occurrence of neural tube defects. JAMA.1988; 260 (21): 3141-5.
15. Shaw GM, Schaffer D, Velie EM, et al. Periconceptional vitamin use, dietary folate, and the occurrence of neural tube defects. Epidemiology.
1995; 6(3):219-26.
16. Smithells RW, Sheppard S, Schorah CJ, et al. Possible prevention of neural-tube defects by periconceptional vitamin supplementation. Lancet. 1980; 1 (8164): 339-40.
17. Vergel RG, Sanchez LR, Heredero BL, et al. Primary prevention of neural tube defects with folic acid supplementation: Cuban experience. Prenat Diagn. 1990; 10(3):149-52.
18. Werler MM, Shapiro S, and Mitchell AA. Periconceptional folic acid exposure and risk of occurrent neural tube defects. JAMA. 1993; 269 (10) : 1257-61.
19. European Surveillance of Congenital Anomalies (EUROCAT). Special Report: Prevention of Neural Tube Defects by Periconceptional Folic Acid Supplementation in Europe. Part IIa -Country Specific Chapters (Austria
to Ireland).2009 [cited 2010 6 April]
20. European Surveillance of Congenital Anomalies (EUROCAT). Special Report: Prevention of Neural Tube Defects by Periconceptional
Folic Acid Supplementation in Europe. Part IIb-Country Specific Chapters (Italy to UK).2009 [cited 2010 6 April]; Available from: http://www.eurocat-network.eu/content
21. Folic acid for the prevention of neural tube defects: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med.2009; 150(9): 626-31.
22. Use of supplements containing folic acid among women of childbearing age-United States, 2007. MMWR Morb Mortal Wkly Rep.2008; 57(1):5-8.
23. European Surveillance of Congenital Anomalies (EUROCAT). Neural Tube Defects (total prevalence per 10,000 births) for all full member registries 2001-2005-2010 [cited 2011 03 March]
24. Tinker SC, Cogswell ME, Devine O, et al. Folic acid intake among U.S. women aged 15-44 years, National Health and

Nutrition Examination Survey, 2003-2006. Am J Prev Med.2010; 38(5):534-42.
25. Cheschier N. Int J Gynaecol Obset.2003; 83(1):123-42.
26. Botto LD, et al. N Engl J Med.1999; 341(20):1509-19.
27. De-Regil LM, et al. Cochrane Database Syst Rev. 2010; (10):CD0007950.
28. Blencowe H, et al. Int J Epidemiol.2010; 39 (Suppl 1):10-21.
29. International Clearinghouse for Birth Defects Surveillance and Research. 2011 annual report (with data for 2009). 2011[cited 2013, 27 May]
30. Rosano A, Botto LD, Botting B, et al. Infant mortality and congenital anomalies from 1950 to 1994: an international perspective. J Epidemio;
Community Health. 2000; 54(9):660-6.
31. Vermaes IP, Janssens JM, Bosman AM, et al. Parents' psychological adjustment in families of children with spina bifida: a meta-analysis.
BMC Pediatr. 2005; 5; 32.
32. Lassmann J, Garibay Gonzalez F, Melchionni JB, et al. Sexual function in adult patients with spina bifida and its impact on quality of life. J Urol.2007; 178(4Pt 2):1611-4.
33. Lemelle JL, Guillemin F, Aubert D, et al. Quality of life and continence in patients with spina bifida. Qual Life Res.2006; 15(9):1481-92.
34. Muller-Godefroy E, Michael T, Poster M, et al. Self-reported health-
related quality of life in children and adolescents with myelomeningocele.
Dev Med Child Neurol. 2008; 50(6):456-61.
35. Padua L, Rendeli C, Rabini A, et al. Health-related quality of life and disability in young patients with spina bifida. Arch Phys Med Rehabil.2002; 83(10):1384-8.
36. Rendeli C, Ausili E, Tabacco F, et al. Assessment of health status in children with spina bifida. Spinal Cord.2005; 43(4): 230-5.
37. Verhoef M, Post MW, Barf HA, et al. Perceived health in young adults with spina bifida. Dev Med Child Neurol. 2007;49(3):192-7
38. Chen CP. Syndromes, disorders and maternal risk factors associated with neural tube defects (V). Taiwan J Obstet Gynecol. 2008; 47(3): 259-66.
39. Deak KL, Siegel DG, George TM, et al. Further evidence for a maternal genetic effect and sex-infiuenced effect contributing to risk for human neural tube defects. Birth Defects Res A Clin Mol Teratol. 2008; 82 (10):662-9.
40. Goh SL, Tan JV, Kwek KY, et al. Recurrent neural tube defects. Singapore Med J. 2006; 47(8):728-9.
41. Daly LE, Kirke PN, Molloy A, et al. Folate levels and neural tube defects. Implications for prevention. JAMA.1995; 274(21):1698-702.
42. Anonymous. Spina bifida and anencephaly before and after folic acid mandate—United States, 1995-1996 and 1999-2000. MMWR Morb Mortal Wkly Reb.2004; 53(17):362-5.
43. Busby A, Abramsky L, Dolk H, et al. Preventing neural tube defects in Europe: population based study. BMJ.2005; 330(7491):574-5.
44. McNulty H and Pentieva K. Folate bioavailability Proc Nutr Soc.2004; 63(4):529-36.
45. McNulty H and Scott JM. Intake and status of folate and related B-vitamins: considerations and challenges in achieving optimal status. Br J Nutr. 2008; 99(Suppl 3):S48-54.
46. Stover PJ. Influence of human genetic variation on nutritional requirements. Am J Clin Nutr.2006; 83(Suppl):436S-42S.
47. McNulty H, Cuskelly GJ, and Ward M. Response of red blood cell folate to intervention: implications for folate recommendations for the prevention of neural tube defects. AM J Clin Nutr.2000; 71(5Suppl):1308S-11S.
48. Wilson RD, Johnson JA,Wyatt P, et al. Pre-conceptional vitamin/ folic acid supplementation 2007: the use of folic acid in combination with a multivitamin supplement for the prevention of neural tube defects and other congenital anomalies. J Obstet Gynaecol Can. 2007; 29(12):1003-26.
49. De Bree A, et al. Folate intake in Europe: recommended, actual and desired intake. Eur J Clin Nutr.1997; 51(10):643-60.
50. Vinas BR, et al. Projected prevalence of inadequate nutrient intakes in Europe. Ann Nutr Metab.2011; 59(2-4):84-95.
51. WHO: Conclusions of a WHO Technical Consultation on folate and Consultation on folate and vitamin B12 deficiencies. Food Nutr Bull. 2008; 29 (2suppl): S238-44.
52. Osterhues A, Holzgreve W, and Michels KB, Shall we put the world on folate? Lancet.2009; 374(9694):959-61.
53. European Health Forum Gastein. Flour fortification: overview and benefits to Europe.2012[cited 2013, 27 May]
54. Abramsky L and Dolk H. Should Europe fortify a staple food with folic acid? Lancet.2007; 369(9562):641-2.
55. Berry RJ, Bailey L, Mulinare J, et al. Fortification of flour with folic acid. Food Nutr Bull. 2010; 31(1Suppl):S22-35.
56. Erickson JD. Folic acid and prevention of spina bifida and anencephaly. 10 years after the U.S. Public Health Service recommendation. MMWR Recomm Rep. 2002; 51(RR-13):1-3.
57. Folate status in women of childbearing age, by race/ethnicity—United States, 1999-2000-2001-2002 and 2003-2004. MMWR Morb Mortal Wkly Rep. 2007; 55(51-52):1377-80.
58. Ganji V and Kafai MR. Trends in serum folate, RBC folate, and circulating total homocysteine concentrations in the United States: analysis of data from National Health and Nutrition Examination Surveys, 1988-1994, 1999-2000, and 2001-2002. J Nutr.2006; 136(1):153-8.
59. Lamers Y, Prinz-Langenohl R, Bramswig S, et al. Red blood cell folate concentrations increase more after supplementation with [6S]-5-methyltetrahydrofolate than with folic acid in women of childbearing age. Am J Clin Nutr. 2006; 84(1):156-61.
60. Verbiest S. Folic acid fortification: should oral contraceptives be next? PRO.MCN Am J Matern Child Nurs.2005; 30(4):228.
61. Von Stenglin A, Buchwald S, and Bannemerschult R. Awareness and periconceptional use of folic acid- results of a European study in women of childbearing age (abstract and oral presentation). Eur J Contracept Reprod Health Care.2010; 15(s1):37-8.
62. Ravin CR. Fortifying oral contraceptives with folic acid. AHONN Lifelines. 2004; 8(1):12-3.
63. Von Stenglin A, Buchwald S, and Lynen R. Women's awareness and use of folate supplements prior to and during pregnancy: a global perspective (abstract and poster). Eur J Contracept Reprod Health Care.2010; 15(s1):111-2.
64. Cronin M, Schellschmidt l, and Dinger J. Rate of pregnancy after using drospirenone and other progestin-containing oral contraceptives. Obstet Gynecol.2009; 114(3):616-22.
65. Diefenbach K, Trummer D, Ebert F, et al. Changes in folate levels following cessation of Yasmin and levomefolate calcium 0.451 mg or folic acid 400 mcg co-administration (abstract and poster). Eur J Contracept Reprod Health Care.2010; 15(s1):157-8.

New at LAUMC-RH: EndoBronchial UltraSound (EBUS)

a safer, quicker and less costly mean of diagnosing chest diseases

LAUMC-RH is expanding its endoscopy suite and has now become one of the few medical centers in Lebanon to offer both patients and doctors a new technology for diagnosing chest diseases: the EndoBronchial UltraSound or EBUS.
EBUS is a bronchoscopic technique that utilizes an ultrasound probe to visualize and accurately localize structures within the chest, allowing the diagnosis of different lung diseases such as cancer, lymphoma, infections, as well as other inflammatory diseases of the chest and mediastinum.
Where indicated, this simple outpatient procedure is minimally invasive and has a higher diagnostic yield than traditional bronchoscopy.
This relatively safe and quick procedure (less than 2 hours) is performed in the endoscopy suite under moderate sedation and allows the patient to go home the same day. The alternative surgical options are more costly, carry an increased morbidity risk and require patient hospitalization.



Infos

L'Etonnante Astuce qui vous Permet de Voir sans vos Lunettes

Porteurs de lunettes et autres lentilles, cette astuce pourrait vous changer la vie ! Comme beaucoup, il vous ait sûrement déjà arrivé d'égarer vos précieuses lunettes et de vous retrouver alors dans une situation délicate, en maudissant vos problèmes de vue. Et bien, désormais, c'est du passé. Une astuce toute bête vous offre en effet la possibilité de faire face à tous types d'imprévus.
Rien de bien compliqué puisqu'il suffit simplement de placer le poing devant votre œil et d'écarter les doigts afin de former ce qui s'apparente à une sorte de longue-vue artisanale. Vous pouvez ensuite regarder à travers et distinguer ce que vous ne verriez normalement pas en l'absence de lunettes. Une astuce bien pratique à appliquer en cas d'urgence, et qui tient en fait à peu de choses.
Tout est une question de lentille

En temps normal, la vision résulte de la focalisation des rayons lumineux sur la rétine. Les rayons parcourent ainsi les différentes composantes de l'œil, de la cornée à la pupille, pour finir leur route sur le cristallin. Ce dernier va, en fonction de la distance de l'objet regardé, modifier sa forme pour focaliser les rayons au niveau de la rétine. L'énergie lumineuse reçue par la rétine sera ensuite convertie en influx nerveux traduits par le cerveau.

Prenons le cas d'un appareil photo. Si ce dernier possède une lentille, visible à l'intérieur de l'objectif, c'est bien pour filtrer en un point précis la lumière émanant de l'extérieur. Il en va de même pour notre œil. Si ce dernier ne possédait pas de lentille, la lumière frapperait cet organe en divers endroits, ne laissant apercevoir qu'une tache imprécise.